REPORT

ON THE

GEOLOGY OF VERMONT:

DESCRIPTIVE, THEORETICAL, ECONOMICAL,

AND

SCENOGRAPHICAL;

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PART IV.

UNSTRATIFIED ROCKS.

BY E. HITCHCOCK, SENIOR.

Most English geological writers call this class of rocks igneous rocks, from a conviction that they derive their present form and character from the influence of heat alone, melting them as in a furnace—that is, by a dry heat. But some able chemists and geologists, although they would not exclude heat, consider hot water to have been the most powerful agent in the production of these rocks. Hence, to call them igneous, might lead to erroneous impressions as to their origin. It is always unwise to use terms in classification which involve theoretical considerations, especially if the theories are not fully settled.

The term unstratified involves no theory, but is merely expressive of a fact about which there is generally no doubt.

Good writers divide the unstratified rocks into three groups: 1. Volcanic. 2. Trappean. 3. Granitic; as already indicated in our tabular view on a previous page. Of the first group Vermont furnishes no example, since no igneous rocks have been protruded within its limits so recently as the period of volcanos. Of the second group, we find in the State dikes and beds of greenstone, and some examples of trachytic porphyry. But the granitic group, in the form of granite, protogine and syenite, is most abundant in the State. In describing these rocks we begin with the latter group, which is usually considered as the oldest.

Unstratified rocks are found in four positions: 1. As irregular masses beneath the stratified rocks. 2. As veins or dikes crossing both the stratified and unstratified. 3. As beds between those of the stratified rocks. 4. As overlying masses. Joints are the only divisional planes found in them, except some of the trap family, which are columnar. We have, however, met with no examples of this last structure in Vermont. The texture of the granitic group is almost entirely crystalline; of the trap group, both crystalline, compact and earthy; and of the volcanic group, almost entirely compact, vitreous, earthy and vesicular.

The older or granitic unstratified rocks differ from the trappean and volcanic in composition. Silicates predominate in the former, though present in all. The granitic have but little of lime, magnesia, or iron, which are abundant in the others. In the former, also, potash is more abundant than in the latter, which contain more soda. These differences make the newer rocks much more fusible than the older, so that they will melt at a less heat. Hence, if these were all mixed together in a fused mass, the granitic varieties on cooling would be first consolidated, while the trappean and volcanic would be squeezed out and become consolidated, one after another, according to their fusibility; and this may be the way in which they were formed at successive epochs.

Feldspar, in some of its forms, is the most common and abundant simple mineral in the unstratified rocks, being present in probably every variety. The potash species, or common feldspar, is called orthoclase. The soda species are albite, oligoclase, &c.; the lime species, anorthite and Labradorite. The hornblendic and augitic minerals are the next most important. Where the feldspars predominate the rock is called feldspathic; where hornblende or augite are abundant, the rocks are called hornblendic, or augitic. Quartz and the different micas are most abundant in the granitic series, and scarcely present in the others.

In the granitic group we place three prominent varieties: 1. Granite. 2. Syenite. 3. Porphyry. Others place the latter rock in the trappean group. But the porphyry of Vermont — small in quantity and of imperfect character — seems to be mostly a variety of granite.

I. GRANITE.

The common statement is, that feldspar, mica and quartz are the normal constituents of granite. But feldspar and mica have now become names for *families* of minerals, so that a more extended description becomes desirable.

"The feldspar of granite," says an able English writer (Jukes), "may be either orthoclase or potash feldspar, frequently flesh-colored, but sometimes white; albite or soda feldspar generally dead-white; an intermixture of these two minerals; or, lastly, a feldspar containing both potash and soda, which may be called soda orthoclase or potash albite, as the case may be. Other varieties of feldspar, except in some instances oligoclase, are never found in granite as constituents of the mass."

"The mica of granite varies greatly in color and luster, being sometimes dark, coppery-brown, passing into black, sometimes green, sometimes golden-yellow, and sometimes a pure silvery-white. The quartz is sometimes colorless or white, but sometimes dark-gray or brown." *Manual of Geology*, p. 77.

The proportions of these minerals varies much in different specimens. The average of four granites from Ireland gave about sixty parts of feldspar, twenty-four parts of quartz, and sixteen of mica. Prof. Phillips assumes the ingredients of common granite to be twenty parts of potash feldspar, five parts of quartz, and two parts of potash mica. This would give the chemical composition of granite as follows:

Silica,	1853
Alumina,	404
Potash,	282
Lime,	40
Oxyd of iron,	44
Oxyd of manganese,	3

One of the usual constituents of granite—more commonly the mica—may be wanting, or replaced by another mineral. This gives rise to several varieties of granite, some of which, because they occur in Vermont, we shall describe below. Bischof in his Chemical and Physical Geology (p. 409, Vol. III.) says that "the accessory constituents of granite are hornblende, garnet, orthite, titanite, apatite, and iron pyrites." Why he should omit talc we know not, unless it be that he regards protogine, which is the name given to that granitic aggregate containing talc, as a rock distinct from granite. For he says of the rock of Mont Blanc, that its "Principal constituents are quartz orthoclase, oligoclase, very ferruginous mica, and a variety of talc, which distinguishes it from granite."—Usually protogine has been regarded as a variety of granite.

VARIETIES OF GRANITE IN VERMONT.

1. *Normal Granite.* In this, which is the most common and wide-spread, the constituents are all present and pretty uniformly diffused through the mass. Sometimes the grain is very coarse, but in Vermont it is usually fine, and admirably fitted for architectural purposes. A better example cannot be referred to than that of which the new State House, at Montpelier, is built. We have never met with a finer kind of granite for public or private buildings and monuments, in this or any other country. Yet it corresponds essentially with the character of all those outbursts of granite along the eastern part of the State, although it is only occasionally that we find places where as fine quarries can be opened as in Barre. But enough can be found there to furnish all New England with granite should it be needed to the end of time.

2. *Protogine.* Protogine has been usually represented (see Lyell's Elements) as a variety of granite in which talc takes the place of mica, and such is its character generally in Vermont. But Bischof, as we have seen, represents the protogine of Mont Blanc, which we believe was the first described under this name as a granite, with mica and oligoclase taking talc in addition. The Mont Blanc protogine is described as having somewhat of a foliated structure, as if it were derived from a stratified rock, as it probably was; and the same is sometimes the case in Vermont. It occurs chiefly in the northeast part of the State, as the catalogue of the specimens will show. As in the case of talcose schist, the mineral which we call talc in this granite may be something else. We have not analyzed it to ascertain whether it contains magnesia.

3. *Pegmatite and Graphic Granite.* These are granular varieties of feldspar and quartz, the latter variety having the quartz so arranged as often exceedingly to resemble the letters of such Oriental languages as the Armenian and Syriac. We have met with no good example of this graphic character in Vermont, but the granular mixture of quartz and feldspar such as we suppose to be pegmatite, is quite common, especially in veins.

4. *Porphyritic.* In this variety, besides the feldspar, which is diffused pretty uniformly through the mass, larger crystalline fragments are scattered among the whole, giving it a porphyritic aspect.

In Vermont this rock is not well developed anywhere, especially if we compare the Vermont rock with its magnificent display in a bed sometimes ten miles wide in New Hampshire, running along the west side of Lake Winnepisiogee, we know not how far. Some of the imbedded crystals of feldspar in this rock are as much as three inches long, and its appearance is very beautiful. We have observed it in several places along a line nearly a hundred miles long, extending as far south, at least, as Harvard, in Massachusetts.

There is, however, a peculiar granite in the southwest part of Vermont, which we incline to refer to this variety. The imbedded feldspar crystals are not usually very distinct, except where the surface has been a good deal weathered. And this is frequently the case, for the rock is very liable to disintegration. Its chief deposit is in Stamford and Pownal, where it forms mountains rivalling in height and size the Green Mountains, of which, in fact, they appear to be spurs. Occasionally we meet with this granite further north, along the west side of the Green Mountain range, and sometimes it is distinctly foliated so that it must be called gneiss, yet all its lithological characters are those of the Stamford granite. See a locality at Ripton Center, on the banks of a small stream. We have observed a similar gneissoid variety in the northwest part of Stamford. The bearings of such a fact upon a theory of the origin of this rock we reserve to a subsequent paragraph.

The great liability of the feldspar in this rock to decomposition, awakened a suspicion that it might be what is called lime feldspar, or Labradorite. But the following analysis of it, by Mr. G. F. Barker, of which a fuller account will be given in the chemical report, shows that it is probably common feldspar, called orthoclase:

Silica,	64.00	66.48
Alumina,	20.40	19.06
Lime,	1.79	.63
Magnesia,	a trace	
Potassa,	9.75	10.52
Soda,	3.37	2.30
Loss by ignition,	.20	
	99.51	98.99

We have subjoined an analysis of orthoclase by Kersten, from Bischof's Chemical and Physical Geology, Vol. II, p. 161, English edition. Its close resemblance to that by Mr. Barker leaves no doubt that the Stamford granite contains orthoclase:

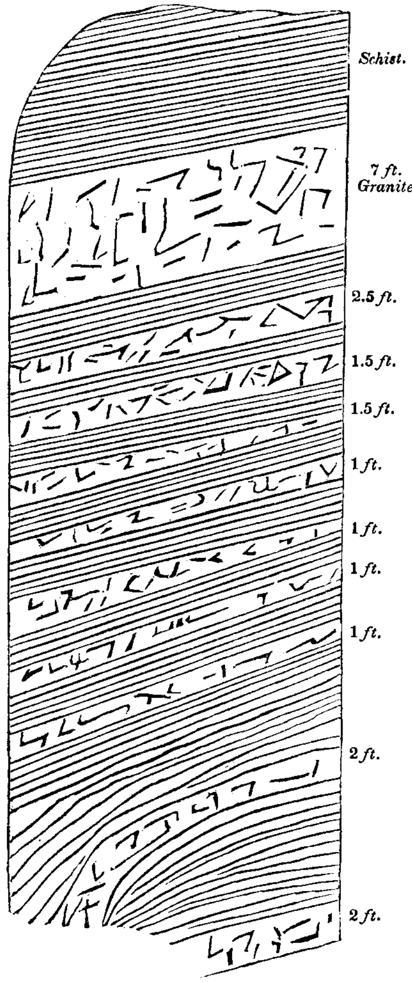
Silica,	65.52
Alumina,	17.61
Peroxyd of iron,	.80
Lime,	.94
Potash,	12.98
Soda,	1.70
	99.55

5. *Tabular or Regularly Jointed.* The structure and composition of this variety have little in them that is peculiar. We note it only because of the regularity of its forms. These result from two causes: First, from its joints; secondly, from its interstratification with slate or schist. All granite is indeed jointed, more or less, but the divisional planes are usually quite irregular. Yet, in the variety under consideration, those planes are essentially parallel. The result is, that the mass is divided into tables, often of large dimensions, but sometimes there are three sets of joints, and the blocks have a rhomboidal form. The tables are sometimes thin enough for flagging stone, as at Barre, but they have no foliation. When the tables are thick, say several feet, and there is only one set of seams, long columns can easily be got out. We noticed a fine locality of this sort in West Dummerston, on a branch of West River, and near the road from Brattleboro to West Dummerston. The rock here is a spur from Black Mountain, and we think that magnificent blocks can be got out there.

The tabular variety of granite is common in the deposits of this rock south of Memphremagog, as in Coventry.

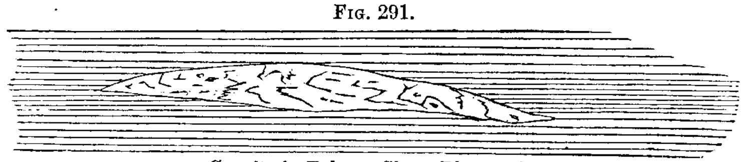
Here the cuboidal division is often quite striking. But it is chiefly in that region where we find parallel masses interstratified with the slate. The adjoining example occurs in the northern part of Coventry, called the Narrows. The sketch, Fig. 290, represents the almost perpendicular face of a ledge of clay slate, some 40 or 50 feet high, on the west side of the road, in the woods. Excepting in the second vein from the bottom we did not discover any crossing of the strata by the granite, but the two rocks appear to be interstratified. Had we followed the series higher up the hill, probably other interstratifications might have been found. The shrubs growing on the face of the cliff greatly impeded our researches. The theoretical conclusions deducible from such a case as this we reserve for the sequel.

Fig. 290.



Granite and Clay Slate, Coventry.

Fig. 291.



Granite in Talcose Slate, Plymouth.

A. D. H. furnishes Fig. 291, which represents an elongated mass of granite in talcose slate, in Plymouth, lying nearly in the direction of the layers of the slate.

A case still more interesting has been already described in the south part of Derby, but further details will be desirable. On the west side of the road leading from Brownington to Derby, in a grass field, on land of Mr. Robbins, may be seen a hummock of granite, surrounded with bushes. On examination, we

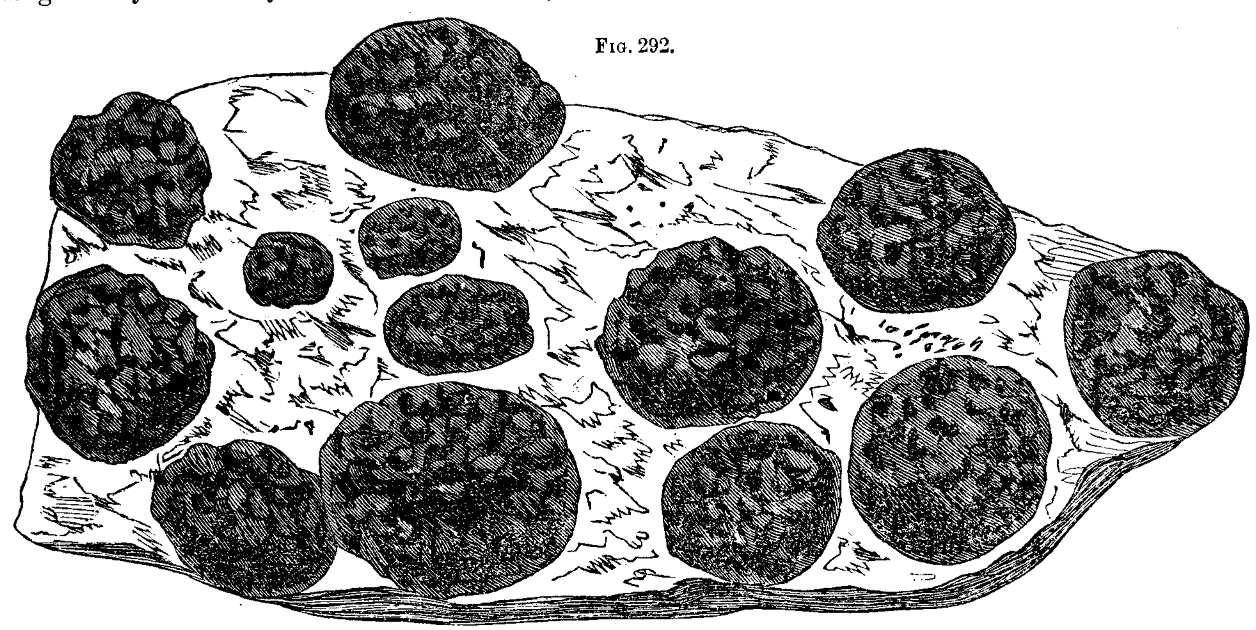
find there a tabular mass of fine-grained granite overlying a gray limestone, very similar in appearance to the limestone further south, in Sudbury, Whiting, &c. The granite projects over the limestone, and the few rather obscure encrinal stems which we found, as stated elsewhere, leads us to regard it as probably of the same age as that containing corals, at Owl's Head, in Canada.

Passing westerly up the wooded hill from the junction of the granite and limestone, on Mr. Robbins' farm, we go over a succession of interstratified rocks, as is represented on Fig. 19. A kind of mica schist is first met, which contains that peculiar species of mica already described under the name of Adamsite. This alternates several times with the granite as we ascend the hill, and there are at least two beds of limestone. Passing westerly over the hills and through the woods, we find a succession of the granite and the schist; but often the latter appears to be intruded into the former, or is certainly in irregular juxtaposition with it. Where we strike the river Clyde, near its mouth, clay slate appears, with a nearly perpendicular dip, and apparently undisturbed, though contiguous to large masses of granite.

This case has an important bearing upon several points in the theory of granite, both as to its origin, and its age. But we reserve its application to the end of the granite section. The chief object we have in view in describing it here is to show the interstratification of granite and other rocks. The granite itself has but little that is peculiar in character: but the idea that masses arranged as these are could have been intruded between the layers of schist and limestone, can hardly be admitted. We passed on foot over the whole section, two or more miles long; but we have not attempted to mark the exact relative position or amount of the different rocks, except at the right hand extremity. We could see that there is a good deal of irregularity in the position of the schist and the granite in other parts, which would require much time to trace out and space to delineate. The region is chiefly wooded and rough over which the section passes, but it would be well worth working out and extending further, especially at the east end. We had no time to do it.

6. *Concretionary.* The basis of this remarkable variety of granite is rather fine-grained, white, and highly feldspathic. The mica, however, is usually dark, and where it exists in large quantity it gives the rocks the aspect of a syenite. But there is no hornblende present. Scattered through this base, occur numerous spherical or elongated and somewhat flattened nodules of black mica, from half an inch to two inches in diameter; and when elongated, the longer axis is sometimes seen as much as four or five inches long. They are usually more or less flattened, and have a shrivelled appearance like dried fruit. They

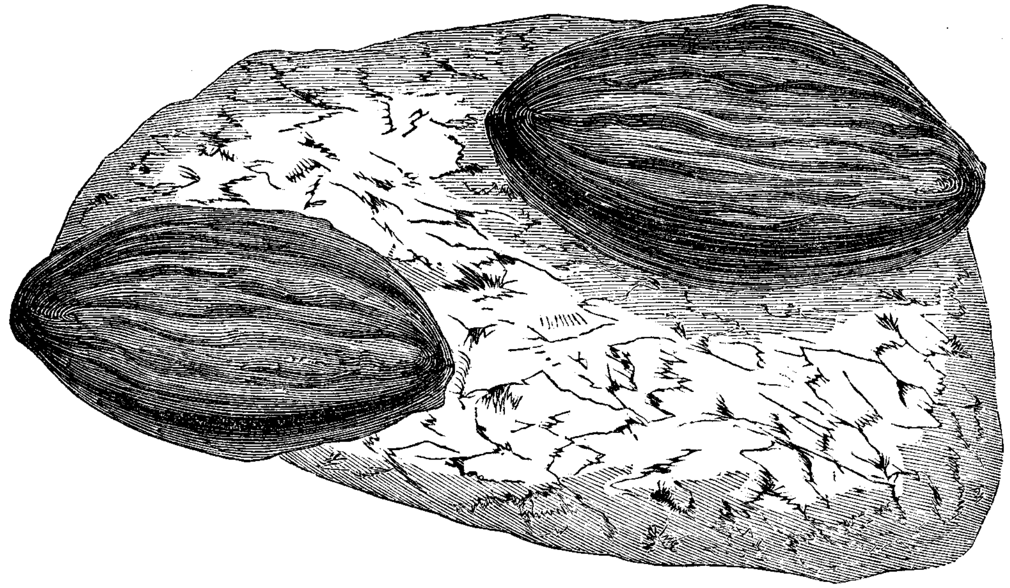
Fig. 292.



sometimes become so thin as to consist of only a few plates of mica. Fig. 292 will give an idea of one of the most perfect specimens. It will be seen that the concretions occupy more than half of the mass. This is the case in the most beautiful specimen we have ever seen, which is in the State Cabinet from Craftsbury, and although greatly injured by the burning of the State House, it is still a superb specimen.

When the nodule is elongated and the wrinkles correspond, as they always do to the longer axis, the resemblance is very striking to a dried butternut, more especially when stripped of its epicarp. No wonder they should be called *petrified butternuts*. When spheroids the resemblance is scarcely less to petrified walnuts, as may be seen in the sketch above, which shows a specimen from Craftsbury. Fig. 293 which follows, was taken from a specimen found in Newfane and represents the butternuts extremely well.

Fig. 293.



If a specimen somewhat flattened be placed on its edge and a moderately sharp blow be given to it with a hammer, concavo-convex scales will be chipped off, even to the center. They are composed of layers of mica, with granular quartz and probably some feldspar interposed. The structure is evidently concretionary; yet, as already intimated, one can hardly avoid the suspicion that something has been abstracted from some of them, causing a shrinkage.

It ought to be mentioned that the position of the elongated and flattened nodules in the rock is such that their largest planes and longest diameters are parallel to each other. This gives to the rock often a somewhat foliated appearance, and affords strong presumption that it was once stratified.

The localities of this granite, as yet discovered in Vermont are few. Craftsbury is one of the most important. It occurs also in Northfield, and Newfane; also in small quantity near Proctorsville. It is found also in Stanstead, just beyond the Canada line. We have found numerous bowlders of it in Waterford and Newbury. Whether these were transported by the drift agency from Stanstead, or Craftsbury, has not been ascertained: but we think it more probable that other localities exist in the granitic region of the northeast part of the State. A rock so remarkable, deserves to have all its localities hunted up. We are not aware that it has been found in any other part of the country, or the world.

Of the origin of the concretions of mica in this granite, we have but little to say. The parallel position of their longer axes affords a presumption that the granite was produced from a stratified rock. If so, these nodules probably existed in the stratified rock, and were metamorphosed into mica, when the granite was formed. Since the mica forms successive laminæ, we should conjecture that the nodules from which it was formed also possessed a concentric structure. But we know of no concretions of this sort in the fossiliferous strata, which could be changed into mica with an excess of silex to produce the grains of quartz, disseminated through the mica. The shrivelled appearance of the nodules in very many cases, suggests the idea that during the metamorphosis some ingredient or ingredients were abstracted. We might

add, that their occasional elongation and still more frequent flattening give rise to the suspicion that, like certain conglomerates already described, they have been subjected to pressure when in a plastic or semi-plastic state. Nay, the facts we have to detail respecting a syenitic conglomerate, will awaken the inquiry whether these concretions may not be metamorphosed pebbles. But we think them too regular to have had such an origin.

7. *Syenite.* The essential ingredients in this important variety of the granitic group, are feldspar and hornblende — the former predominating. Generally, however, mica and quartz are present. According to Bischof, two species of feldspar frequently occur in it, viz., orthoclase and oligoclase. A syenite of this latter class, containing 70 per cent. of silica, has the ingredients in the following proportions:

Orthoclase, . . .	33.58 containing Silica,	21.58
Oligoclase, ...	17.57	10.35
Hornblende, . . .	20.50	9.72
Quartz, ...	28.35	28.35
	100.00	70.00

Rose describes four varieties of syenite according to its ingredients: 1. Feldspar and hornblende. 2. Feldspar, oligoclase and hornblende. 3 Feldspar, hornblende, oligoclase, green magnesian mica and quartz. 4. Feldspar, oligoclase and green mica. All these doubtless occur in New England, though it has not been common here to distinguish the soda feldspar called oligoclase from common feldspar.

This rock in our country is only a variety of granite, yet it passes into greenstone. The syenite of Vermont may be described under two varieties:

1. *Normal Syenite.* Usually this variety contains along with feldspar as the chief ingredient, some hornblende, quartz and mica, and sometimes it consists almost entirely of feldspar; nor is it easy in some cases to draw the line between this syenite and some forms of granite. Indeed the syenite of Vermont is not generally well characterized, as it is in Massachusetts at Quincy and in the Connecticut valley. Its principal locality in Vermont is on Ascutney, where it is so mixed with, and passes so insensibly into granite, that an attempt to give them a separate outline on the geological map would be useless. At Bellows Falls the rock, on the Vermont side of the river, would generally be called gneiss, although both the foliation and the stratification are obscure. But on the east side of the river in New Hampshire, as we go towards Charlestown, the syenitic character of the rock is very decided. It is there connected with a sort of clay slate passing into mica schist.

2. *Conglomerate Syenite.* This unique variety has as yet been found only in a few localities along the line of the Connecticut valley and in comparatively small quantity; but the important scientific inferences derived from it, make it of unusual interest. It may be described as a conglomerate whose cement is syenite; or as a syenite through which are scattered pebbles mechanically rounded. Generally the pebbles are more or less metamorphosed, and sometimes almost converted into syenite subsequent to their introduction into the syenite. In their present state we have noticed white quartz, mica schist, hornblende schist and hornblende.

We know at present of but four localities of this rock, and one of these is in Massachusetts in Whately. The conglomerate here lies in near proximity to hornblende schist, yet the pebbles are only occasionally met with. This locality was fully described in the Report on the Geology of Massachusetts in 1840, where the inference is drawn, that probably the syenite resulted from a metamorphosis of the hornblende schist.— Most of the pebbles are of this latter rock, though specimens more recently found contain fragments of other schists, highly silicious, which appear to be in that intermediate state which makes it difficult to identify them—in other words, to determine to what rock or aqueous origin they originally belonged. The best specimen we have seen, which was a bowlder in Northampton, has a cement mostly of hornblende, united, however, with feldspar.

The second locality is on Ascutney. In various parts of the mountain, Great as well as Little Ascutney, we see dark rounded masses, which were probably once pebbles, but are now either crystalline hornblende or hornblende and feldspar approximating to syenite. But if we ascend Little Ascutney, near its west end, on the top, just where the southern slope begins, masses of a conglomerate of a decided character, several feet and even rods wide, appear on the side of porphyry and granite. All traces of stratification in the conglomerate are lost, and it passes first into an imperfect porphyry, and this into granite, without hornblende, in the same continuous mass, without any kind of a divisional plane between them. Where the conglomerate is least altered it is made up almost entirely of quartz pebbles and a larger amount of laminated grits and slate, the fragments rounded somewhat, and the cement in small quantity. It is easy to see that a metamorphosis has taken place in all the conglomerates, and some of the pebbles might even be called mica schist. In the cement, also, we sometimes see facets of feldspar. In short, it is easy to believe that the process of change need only to be carried further to produce syenite, porphyry, or granite. One cannot resist the conviction that the granite rocks of this mountain are nothing more than conglomerate melted down and crystallized, or at least that such was the origin of a part of them. We seem at this locality, discovered by one of our number (C. H. H.), to have an exhibition of the process of the conversion of a decided conglomerate into granitic rocks.

Fig. 294.

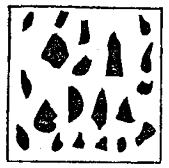
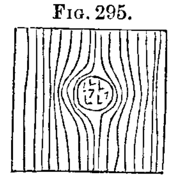


Fig. 294 represents a yard square of the syenite in some of the dikes at the falls upon the west side of Ascutney. The black spots are the hornblendic masses, such as may be seen in bowlders at the foot of the mountain.

Fig. 295 represents a horizontal section of a dike (?) of syenite, on the west side of Ascutney, in gneiss. The round spot in the middle of the figure is the syenite, fifteen feet in diameter. The other lines indicate the disturbance in the strata, caused by the outburst of the melted matter (according to the old notions.) This dike (and others) is about three-fourths of a mile from the granite of Ascutney.

Fig. 295.



We are unable to make a satisfactory conjecture even as to the age of this conglomerate. It certainly has a good deal of resemblance to the brecciated conglomerate constituting the upper part of Mount Mettawampe, in Sunderland, in Massachusetts, although the latter is much the coarsest. But this is of oolite, certainly not older than triassic age, and no trace of granitic veins has ever been found in it. We cannot believe that Ascutney is so recent as the oolite or trias. We have evidence nowhere else in New England of any granitic rocks more recent than the Devonian period. But we are not aware of the occurrence in that group, in our country, of any such conglomerate as that of which a remnant is preserved on Ascutney, and in two or three other places in the Connecticut valley.

A third variety of this conglomerate, or breccia, is in Barnet. We cannot say much of the locality; for when it was discovered by C. H. H. he was not aware of its importance, and therefore only obtained a specimen (No. $\frac{10}{18}$) for the State Cabinet. He recollects only that the rock resembles that on Ascutney.

A fourth locality of this conglomerate is in Granby in northeastern Vermont. It was first brought to our notice by Rev. S. R. Hall,—and though we have found a specimen of it in one of the collections made in the first Survey by Prof. Adams, we presume Mr. Hall obtained it. He represents the rock as occurring only in bowlders near the meeting house.

The specimens in the State Cabinet obtained there, show nodules of white somewhat vitreous quartz, mica schist and hornblende schist. These are imbedded in a fine-grained syenite, which in some parts passes into an imperfect mica schist. The nodules occupy but a small part of the mass so far as we can judge from the specimens, and they rarely exceed four or five inches in their longest diameter. Others are larger, however, according to Mr. Hall's description which follows: "The bowlders," he says, "are of all sizes from a few hundred pounds to fifty or sixty tons. They cover many acres, associated with those of contorted mica slate, quartzose granite and many other varieties common in the region. From the best information I could obtain, there is a ledge of similar rock in East Haven, or Victory, several miles northwesterly. But I could not visit the place, as no one could accompany me who knew anything about it except by 'hearsay.' North of Granby the wilderness extends mostly to Canada.

"Quartz fragments in the rock are more common than any other, and being harder than the base they protrude frequently an inch. They are from the size of a pea to that of a man's head."

The important bearing of these facts upon the theory of the origin of the granitic rocks of eastern

Vermont is quite obvious; but we reserve their application to a subsequent page, when we shall have described all the varieties.

8. *Porphyry.* By some writers porphyry is placed in the trappean group of unstratified rocks. But nearly all which we have seen in Vermont is but a variety of granite. It is that variety which goes by the name of feldspar porphyry; that is, the base is a feldspar whose crystalline structure is mostly obliterated through which distinct crystalline masses of the same mineral are thickly scattered. It may consist of other bases and other disseminated crystals, but these varieties are not feldspar porphyry. According to Bischof this latter variety may contain orthoclase, oligoclase, quartz and magnesian mica. The matrix or base is probably an intimate mixture of the same minerals. By an analysis of six specimens from different localities, the mean maximum amount of feldspar was 65.91 in 100, and the minimum amount of quartz 28.49. We place below a single ultimate analysis of granite and porphyry side by side. Both are from Germany, and are given by Bischof. They are so nearly alike as to justify this writer in the conclusion that "feldspar porphyry is so intimately related to granite that they may be regarded as chemically identical." (*Chemical Geology*, Vol. III, page 430.)

	Granite.		*Porphyry.*
Silica,	71.46		70.50
Alumina,	15.57		13.50
Peroxyd of iron,	1.51	Perox. iron,	5.50
Peroxyd of manganese,	.09		
Lime,	1.43		.25
Magnesia,	.58		.40
Potash,	6.39		5.50
Soda,	1.03		3.55
Water,	.76		.77
Chlorine,			.10
	100.12		100.07

The porphyry of Ascutney Mountain corresponds to the above description. It does not occur there in much quantity, nor is it easy always to distinguish it from granite, and especially from syenite. The base has not usually lost all its lamellar structure, but the facets of the feldspar are too dull, from incipient decomposition, to reflect the light with the brilliancy of the unaltered mineral. This property, however, is retained for the most part by the disseminated crystals. On weathered surfaces these also become dull, and assume a white color, so as to give the rock that spotted appearance peculiar to porphyry. In position, the porphyry lies next to the conglomerate, on Little Ascutney, as we have shown in another place. Indeed, wherever we have seen this rock as the result of metamorphosis, it has seemed to be one of the intermediate states between stratified and unstratified rocks, and to be the result of a less powerful heat or metamorphic action than granite. Whether it be formed earlier than syenite, we have not been able to determine; that is, we know not which has demanded the most powerful exercise of metamorphic agents. Syenite, however, melts easier than pure granite, and therefore was probably first formed.

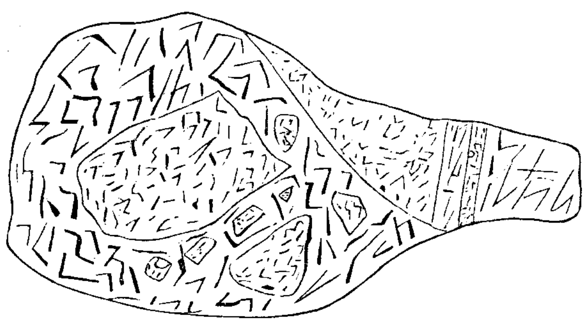
Some of the dikes along the shores of Lake Champlain doubtless deserve the name of porphyry. In some cases, however, they appear to be real trachyte, as we shall show in another place. These dikes are, for the most part, so connected with the trap rocks, that it will be more convenient to describe them under that group.

GRANITIC VEINS.

All the varieties of the granitic group of rocks that have been described, occur occasionally in veins, and it is an interesting form, important also in its theoretical bearings. We shall select the most striking out of the multitude of examples that have fallen under our notice in the State.

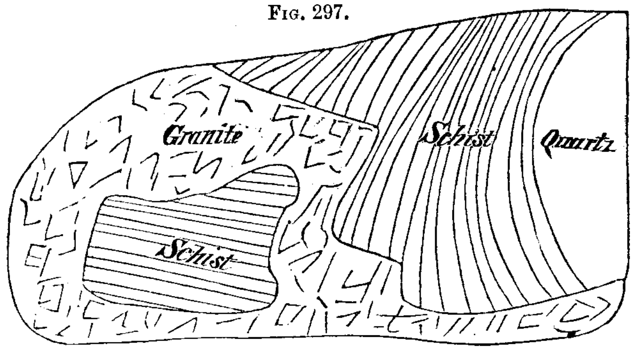
It ought to be premised, that these veins not only extend from the masses of quartz into the schists that lie contiguous, but they also cross the granite; that is, veins, coarser or finer than the base, are seen traversing it, and often cutting one another. In some instances, two varieties, say granite and syenite, so cross and interpenetrate each other, that it is not easy to say which is the original rock, and which the vein. We give the following example (Fig. 296) of a spot, three rods long, on the west side of Ascutney, of this juxtaposition and interpenetration of granite and syenite. In this case, however, we may presume that the syenite was the original rock, and subsequently so invaded by granite as to produce insulated masses of the former, that appear as if they had floated as islands in the fused granite, as we sometimes see matter that is melting in a furnace. The parts that are dotted, represent the syenite, and those with irregular lines, the granite.

Fig. 296.



Veins in Syenite, Mount Ascutney.

Fig. 297.

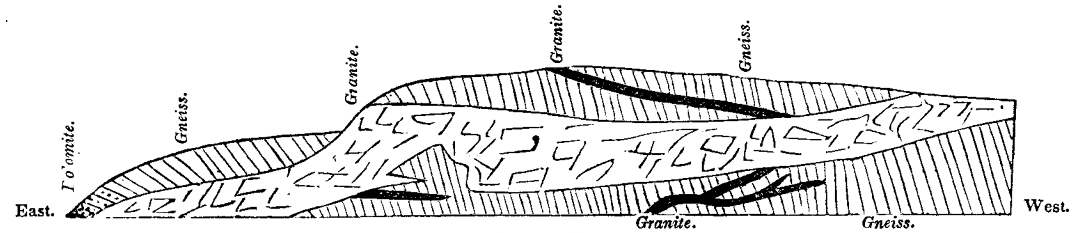


Granite and Schist, Salem.

Not unfrequently, along the ragged junction of granite and the schists, we find the latter thrown out of their normal position. The above sketch (Fig. 297) shows a case of this kind. The original may be seen by the roadside in the north part of Salem, on the stage route to Derby, where the granite appears in contact with mica schist. The schist here is considerably modified and embraces an unusual quantity of quartz, even in large tubercular masses.

The two following sections were obtained at a cut on the Rutland and Burlington railroad from thirty to forty feet deep, a little south of the village of Duttonsville in Cavendish. They are a little over 200 feet long. The south side section (Fig. 298) is inverted so as to be more easily compared with the other

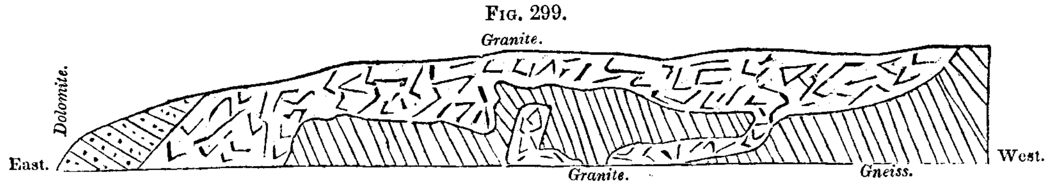
Fig. 298.



North side.

(Fig. 299.) The granite vein has a northerly dip, and it is thrust in very irregularly among the strata of gneiss. Yet these do not appear to be greatly disturbed. Still some mechanical displacement is obvious.

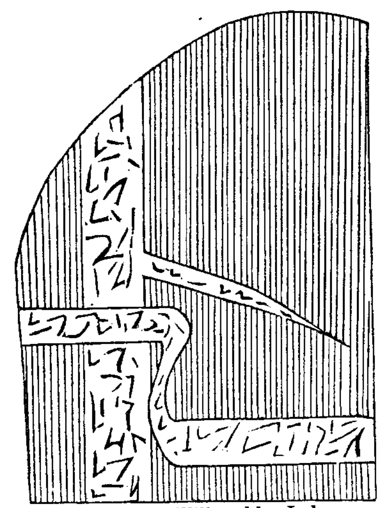
Fig. 299.



South side.

Fig. 300 shows the edges of strata of mica schist, twelve feet wide and fifteen feet high, on the east side of Lake Willoughby, where the almost perpendicular mountain presses hard upon the road. The widest vein (eighteen inches) is parallel to the strata and seems to be a bed rather than a vein, though perhaps not. Its texture is finer than that of the veins which cross the strata. The principal one of this kind seems to have been subject to a downward thrust by the movement of the schist, and at the same time to have been pressed perpendicular to the folia so as to be almost pinched off.

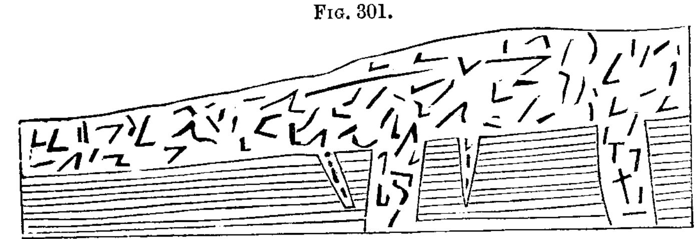
Fig. 300.



East side of Willoughby Lake.

The next example is that very interesting one, already described in its other relations under mica schist, in the south part of Derby. The bluff there rising up shows the granite, ten feet thick, overlying Devonian

Fig. 301.



Granite above fossiliferous Limestone, Derby.

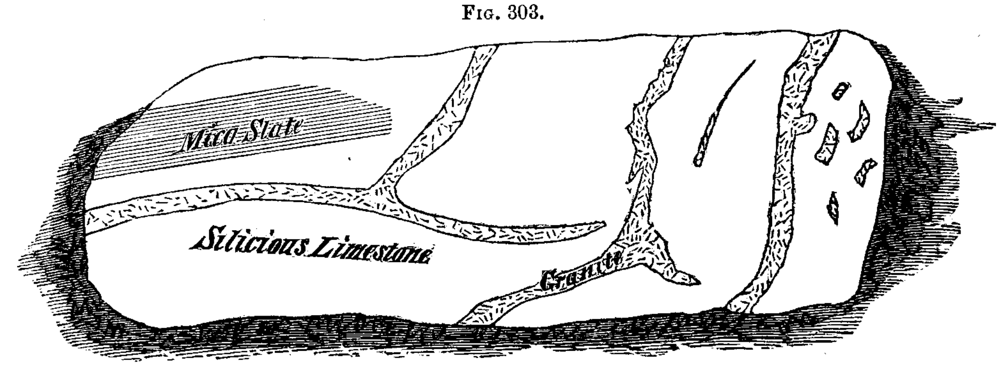
limestone as distinctly almost as in Fig. 301. The limestone is only six feet thick above the soil, but in it are four granite veins, connecting with the mass above. Two of them, the smallest, terminate before proceeding many feet. This is a rare occurrence, although an upward or horizontal termination is not unusual.

The calciferous mica schist not unfrequently exhibits striking examples of granite veins. They are, however, mostly feldspar with little quartz and rarely any mica. They are remarkable, also, for being very tortuous, even where the limestone shows no divisional planes. Yet the curvatures are so short as to preclude the idea that a rock could have been cracked mechanically in so very ragged a manner. And yet sometimes the vein tapers to a point, just as a crack often does. But more of this in the sequel.

We find among Prof. Thompson's notes a beautiful drawing of a net work of these veins in Marshfield, where they appear to be unusually fine. In this case the schist has disintegrated more than the granite so as to leave the veins standing out in bold relief.

One of our number (A. D. Hager) obtained the following sketches of veins analogous to the preceding, near the center of Marshfield village. (See Figs. 303 and 304.) They traverse calciferous mica schist, or rather silicious limestone. Figure 303 shows a perpendicular ledge forty feet long and seven feet high.

Fig. 303.



Veins of Granite in Marshfield.

Figure 304 shows a horizontal surface twenty-six feet long and ten feet wide.

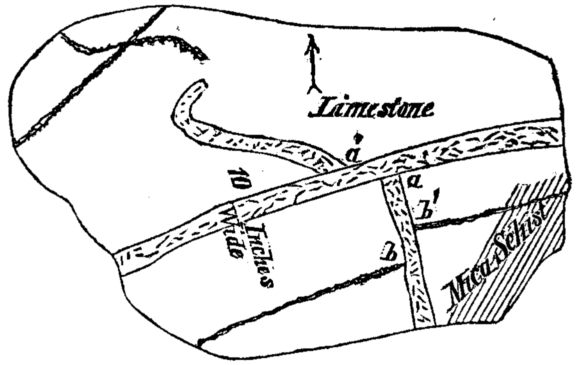


FIG. 304. — Granite veins in Limestone.

A. D. H. furnishes also the sketch on Fig. 305, taken on Ascutney, showing granite veins in quartz rock, at a cataract on a brook, on the southwest side of the mountain.

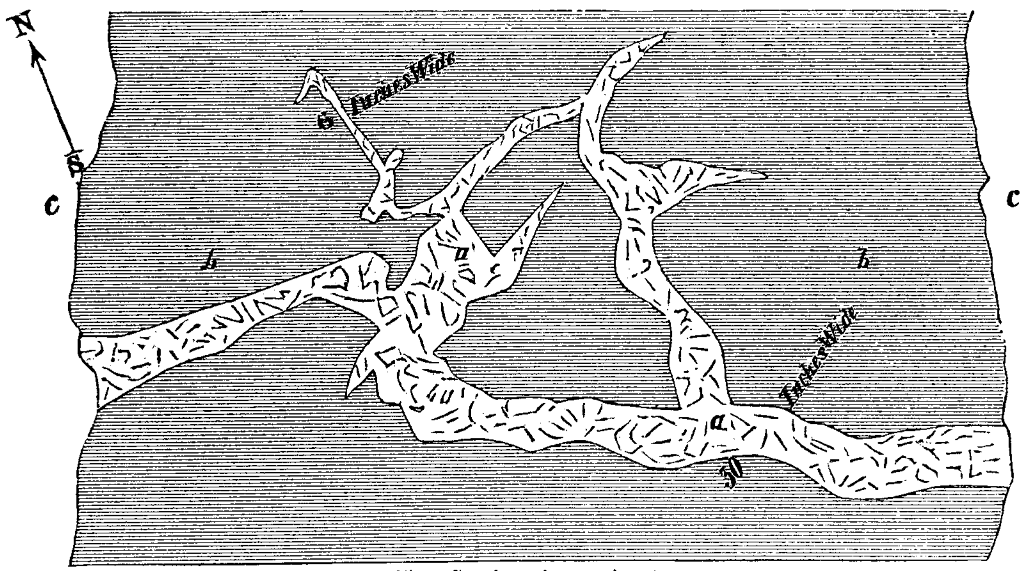


FIG. 305. — Granite veins on Ascutney.

A. D. H. also gives Fig. 306, showing an outcrop of granite in talcose schist in Plymouth, where the strata are much contorted. The granite contains angular fragments of the schist and sends off two veins into it.

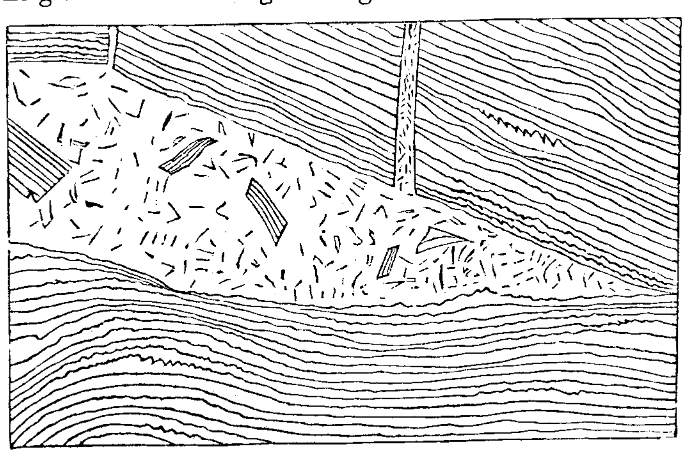
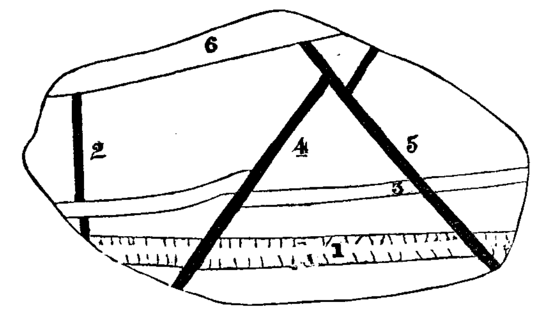


FIG. 306. — Granite in Talcose Schist.

We give the two following examples of granite veins in granite from bowlders on the east side of Lake Willoughby, somewhat north of the mountain, and only a few rods east of the road along the lake. The granite itself is rather fine and highly feldspathic, and the veins traversing it are usually either of a finer or coarser grain. Some of them appear to be veins of segregation, rather than injection. But where one vein cuts off another and the one cut off is displaced, the presumption is that the one which cuts off the other is a vein of injection. The bowlder (Fig. 307) is six feet by ten, and ovoid. Vein No. 1 is about six inches wide; Nos. 2 and 5 only half an inch; No. 3 three-quarters of an inch; No. 4 two inches, and No. 6 three inches. Two facts are of special interest in these veins: First, one of them, No. 1, is fine-grained in the middle, but has two fringes quite coarse on the outside — a fact which we do not remember to have met before. Secondly, we can trace here six periods, and including the granite base itself seven periods of formation — or as most would say, of injection. Thus No. 1 is cut off by all the veins that cross it. No. 2 is cut by Nos. 3 and 6, and probably cuts No. 1. No. 3 cuts No. 2 and is therefore younger. No. 4 cuts No. 3, and is newer. No. 5 cuts No. 4 as well as 1 and 3, and is hence of later date, and No. 6 cuts Nos. 2 and 5. The bowlder itself must have had an earlier production than the veins, so that we have seven periods of formation. This is an unusually large number, and seldom exceeded in any other place.

FIG. 307.



In the next figure (Fig. 308), which represents a rather larger bowlder from the same locality, we are not able to make out as many periods of production, probably because the veins do not so cross one another that we can in all cases ascertain their relative ages. No. 1 is cut by No. 2, and this by No. 3, though by the drawing No. 2 seems to cut one branch of No. 3, and we must follow the drawing since we have not access to the specimen. We thus ascertain four successive epochs of production, and could we connect the veins on the lower part of the drawing with Nos. 1 and 2, we might find them intermediate between these and No. 4 or older. Nos. 2 and 4 appear like veins of segregation, coalescing as they do imperceptibly with the adjoining rock.

FIG. 308.

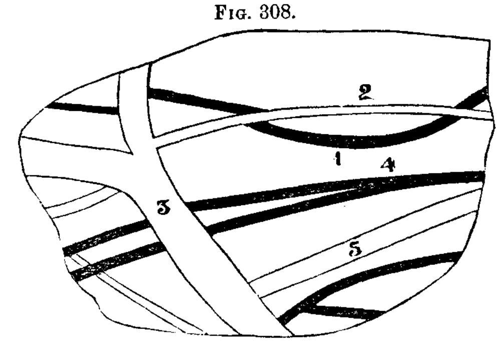
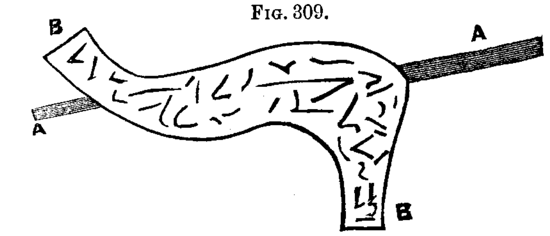


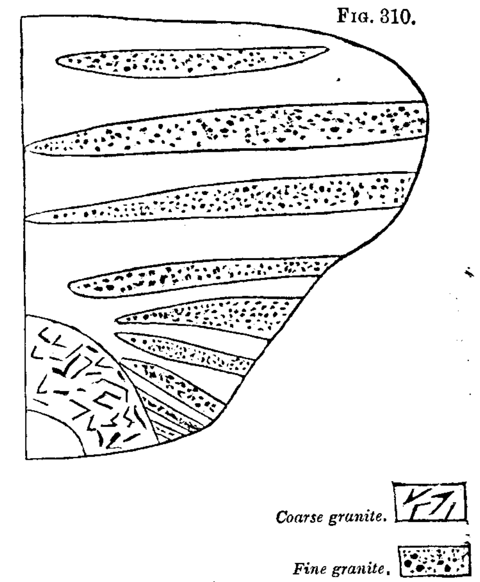
Figure 309 shows a segregated vein, A, A, cut off by B, B, injected granite vein. The distance of the two parts of the segregated vein is three feet. The sketch is from a bowlder of granite on Lake Willoughby.

FIG. 309.



In Fig. 310 we have parallel bands of fine granite in that somewhat coarse, and one coarse vein. The finer bands and acuminate masses are probably veins, but rather inexplicable by the common theories. They occur in a bowlder on the east side of Willoughby Lake.

FIG. 310.



The region around Lake Willoughby would doubtless afford other important examples of granite veins. Another locality, of which we have seen enough to know that it has great interest, is on the west side of Black Mountain in West Dummerston. On the west side of the road, leading from Brattleboro to Newfane, we have noticed complicated net-works of veins that deserve study, but we have never found a day (and such complicated cases can rarely be studied out and sketched in much less than a day) to devote to them. But they ought to be studied; for in our judgment the common theories of veins composed of unstratified rocks, is very unsatisfactory. To some theoretical considerations concerning the granitic rocks we now proceed.

THEORIES OF THE ORIGIN AND PRODUCTION OF THE GRANITIC ROCKS.

The study of metamorphism among the stratified rocks has led to some modification of views respecting the origin of the unstratified. The new views may not be as yet fully settled; but progress has been made in the right direction, and we would indicate in what respects.

1. Since the days of Werner it has been considered a settled principle that granite generally forms the nucleus and the axis of mountains, and that the stratified rocks lie upon the granite anticlinally—that is, dipping away from the central nucleus. But, because it is sometimes so, and happened to be so in some mountains examined by Werner, geologists seem to have adopted so convenient a principle without much examination. It is not generally so in the mountains of this country. It may be so sometimes in the Rocky Mountains, but not in the Apalachian, or White Mountains. Possibly it may be so in northeastern New York, but it is not so in the Green Mountains, and but seldom in any part of Vermont. We have, indeed, in this State, lofty peaks of granite; but the stratified rocks do not slope generally away from their apices, as if lifted up by the protrusion of the granite. Indeed, this rock, in New England, at least, more often shows itself near the base of our mountains than at their summits.

2. Another principle that has been considered as well settled is, that the protrusion of granite in a melted state has been a principal cause of the elevation of strata and of mountains, and of the dislocations and vertical and lateral movements in the stratified rocks. But if the granitic rocks do not generally form the axes of mountains, how could they produce their elevation? Moreover, we find very often that rocks dip in the same direction on both sides of the granitic masses, and that these are sometimes more or less embraced as beds among the strata. Again, the most enormous outbursts of granite which any of its masses could have made, would have only a quite limited effect; certainly they could not have tilted up strata over areas hundreds of miles in extent, which we sometimes find dipping in the same direction, and must owe their position to some more general cause. True, we do sometimes find, where granite masses come in contact with stratified rocks, that the latter have been more or less disturbed and broken, but only to a very limited extent, and often not at all.

3. The influence of the granitic rocks has been by some regarded as the chief agency for the extensive metamorphisms which the stratified rocks have experienced. They have, indeed, produced some effect of this sort, as we have described; for instance, around Ascutney. But how absurd the idea that the azoic strata, confessedly metamorphic, stretching more than a thousand miles southwesterly from Canada, have been transformed and with almost uniform effect, by the few outbursts of granite along that line!

The truth is, we must bring in some more general cause than the unstratified rocks to explain the vertical movements and displacements of the stratified rocks, as well as their metamorphism. The unstratified masses have partaken of the general movement, but have not caused or controlled it. They have produced some analogous effects, but only on a limited scale. In treating of the stratified rocks we have given our views of the nature of the forces by which they have been plicated, elevated and metamorphosed.

4. The granitic have almost universally been regarded as intrusive rocks; that is, as thrust in a melted state into cracks and between the strata of other rocks. But the opinion is now gaining ground, that in many cases, perhaps in nearly all, they are merely stratified rocks, which by heat, or the joint action of heat and water, have lost their stratification, and assumed new crystalline forms. They are, in fact, an extensive product of metamorphism.

These views certainly derive strong support, so far as the granites of the Connecticut valley are concerned, from the facts we have stated as to the syenitic conglomerate in at least four widely separated localities. It seems difficult to resist the conviction that those granites have resulted from conglomerates, which, in some cases, were not quite melted down. In the pure granite, indeed, we do not find any unmelted fragments. But at the meeting of the American Scientific Association, in Springfield, in 1859, Prof. Hubbard, of Hanover, as has been elsewhere stated, exhibited an interesting specimen of pure white granite, from New Hampshire, in which was imbedded a rounded bowlder of hornblende, more than a foot in diameter. It was not, probably, hornblende when introduced into the granite; but no one could look at it without being satisfied that it had been mechanically rounded; and if so, the conclusion is easily reached that the granite had been formed out of conglomerate.

The position of the stratified rocks around Ascutney favors the same view as to that mountain: for, excepting in limited spots close to the syenite, the strike and dip are not essentially changed. Yet, the mountain does not seem to lie among the strata as a vast bed, for its east and west axis is much longer than the north south diameter, and the strata, with a high easterly dip, abut against the north and south sides of the mountain. But, suppose the place now occupied by the granite to have been once filled by conglomerate and other stratified rocks, and then heat from the interior (with or without water) sufficient to melt them, to have permeated upward. Granitic rocks might have been the result, without much disturbance of the adjoining strata.

We suggest another fact, which may favor the same views as to the origin of the Vermont granite. If our northern Sections X, XII and XIII, be examined, it will be seen that a wide region of granite is represented as protruding through the calciferous mica schist. Now, if such masses had actually been crowded in between the strata from beneath, it would have pushed them asunder so that we should find as much width of the upturned edges of the formation, as on those Sections where there is no granite: whereas the whole width, including the granite, is just about the same as where there is none. This would be the case if the granite were only metamorphosed schist. We do not feel much confidence in this argument, but thought the suggestion worth throwing out.

5. Since the time of Hutton, the general opinion among geologists has been that the granitic rocks have been in a melted state; and as Sir Charles Lyell states the matter,

"like the lava of volcanos, they have afterwards cooled and crystallized, but with extreme slowness, and under conditions very different from those of bodies cooling in the open air." One of these conditions was an enormous pressure upon the molten mass, either by superincumbent stratified rocks, or a deep ocean. The fusion, it has been supposed, resulted entirely from dry heat, and water as an agent of solution or crystallization, has been entirely excluded. It was thought that the ingredients of granitic rocks could not be dissolved, to much extent, by water. And then granite is thrust into every crack and often between the layers of the stratified rocks, in the form of veins and bedded or irregular masses, just as melted matter would be under heavy pressure. In many cases, also, the adjoining strata have suffered mechanical displacement, such as the forcible injection of melted matter would produce. For a considerable distance around the granitic masses also, the strata are frequently indurated and metamorphosed as if by heat; a fact that seems to decide the question of the emanation of much heat from granitic foci.

In spite, however, of these strong arguments, able geologists at the present day advance the opinion that water has been a most important agent in the production of the granitic family, or, to use a chemical phrase, these rocks have been produced *in the wet way*,—that is, from a solution, or rather a semi-fusion in water. They take the ground that the water need not have had a temperature higher than—perhaps not as high as—a red heat. These views have been gradually brought out by such writers as Scrope, Sheerer, Elie de Beaumont, and in this country in the able papers of T. Sterry Hunt, Esq., of the Canada Survey, which have done much for chemical geology; and still more, in detail, in the great work of Bischof on Chemical and Physical Geology, which has recently been presented in an English dress by the Cavendish Society. The principal arguments for these views are the following:

1. If it be admitted, as under the stratified rocks we have endeavored to show, that the azoic strata have been brought into a plastic state since their original consolidation, by the agency of water, it is difficult not to extend the same conclusions to the granitic rocks. For some of them are composed of the same ingredients, and they pass so insensibly into one another, that we often cannot tell what name to give to the formation. We could point to districts of considerable extent where an occasional appearance of foliation is the only evidence that the rock is not granite. According to Mr. Hall, it is difficult to draw the line between the gneiss and granite in northeastern Vermont, and around Bellows Falls it is no easy matter to decide whether the rock be gneiss or syenite. The same is true of the gneiss in the region of Jamaica. In such a case, how absurd to suppose that if hot water made the gneiss plastic, its influence ceased with the lowest trace of foliation, and did not act on the same materials below! How much more probable that the granite is the result of a metamorphic influence, carried so far, probably, from a higher temperature, as to make the fusion more complete, obliterating both stratification and foliation, and giving rise to more perfect crystallization.

It may be objected that a heat so high as to bring granitic materials into a melted state would expel all the water, if it had ever permeated so deep. It might be so if the melted materials were at the surface. But suppose them buried by thousands of feet of solid rock; moreover suppose the materials were some stratified rock, say a conglomerate, which had been deposited from water, and was of course permeated by it. Again, suppose the water to contain some reagents that will reduce the point of fusion. Under such circumstances we need not require such a temperature as would be necessary to melt the rocks by dry heat alone. We might also refer to other corrosive vapors besides steam, that issue from volcanos, and if confined would penetrate rocks more powerfully than water, and recollect their remarkable powers in rendering even porphyry and granite plastic at the Geysers of California, as Prof. Forest Shepard, as quoted on a previous page, has described, we need not admit a heat as great as that of molten lava to change the most refractory rocks into granite. We can readily admit the opinion of Bischof, that "steam in the bowels of the earth, having a temperature equal to, or even greater, than the melting point of lava, and having an elasticity of which even Papin's digester can give but a faint idea, may convert rocks into liquid matter:" (*Lyell's Elements of Geology*, p. 477.) Or the opinion of Sheerer, as quoted by T. S. Hunt, in his paper on "the theory of igneous rocks and volcanos," that the presence of a small amount of water, perhaps five or ten per cent., may suffice at a temperature which may approach that of redness, to give to a granitic mass a liquidity, partaking at once of the characters of an igneous and an aqueous fusion.

In forming an idea of the maximum temperature requisite for such a purpose, however, we must not forget that, as the Vermont rocks teach us, not only must a refractory conglomerate be reduced to fusion, but we are to explain the induration of strata from a quarter to half a mile from the melted mass, as may be seen around Ascutney. We doubt whether a mere red heat would be sufficient. Yet this is a matter of mere opinion, for we know of no experiments that cast light upon it.

As to the existence of water deep in the earth, and where the heat is very great, why is it not proved by the vast quantities of vapor that issue with every volcanic eruption? How it gets there and is retained, we may not know; but its escape when the volcano is uncapped, proves its presence.

2. A second argument for the igneo-aqueous origin of the granitic rocks, is found in the order in which their ingredients appear to have been solidified. These ingredients require different degrees of heat for their fusion, and when solidifying from a fused state, as the temperature sunk, those fusible with the most difficulty would crystallize first, and the order of crystallization would be inversely that of fusibility. Now quartz is the most difficultly fusible of all the ingredients of granite. But we find that in fact it crystallized last. For while it is often impressed by the feldspar and the mica, the latter are never penetrated by the quartz. But if formed from aqueous solution, quartz would be one of the residual products of the formation of the other ingredients. When Daubree passed the vapor of the chloride of silicons over bases at a red heat, chlorides were produced with silica, sometimes in a free state and sometimes united with the bases, and he thinks that this fact explains the manner in which quartz exists in granite.

3. The existence in granitic rocks of hydrated simple minerals, or of such as must have been formed in the wet way, or of such as would undergo partial or entire decomposition, even at a red heat, is adduced as another argument in support of the igneo-aqueous theory. Among these minerals may be mentioned the zeolitic family (some of which occur in the gneissoid syenite of Bellows Falls), also iron pyrites, which at a red heat loses one half of its sulphur and has been produced in the wet way. Epidote is mentioned by Bischof

along with many other minerals. Indeed he will hardly admit that any silicates could be formed by simple fusion. He supposes that most of them in the rocks have been produced by aqueous agency since the original formation of the rocks; for he maintains that "all rocks are continually subject to alteration, and their sound appearance is not any indication that alteration has not taken place." (Vol. III, p. 426.)

4. Bischof finds an argument for this theory in the character of granitic veins. Some of these, as they ramify, become very narrow — in some cases not thicker than writing paper. We have similar veins in our country, and those of epidote in syenite, in the Connecticut valley, are rarely more than half an inch wide. Yet these more frequently form faults—that is, the opposite sides of the rock have been slid along each other—than do the granite veins. Now, Bischof thinks that melted matter could never have been driven into such narrow crevices. He cut channels in sandstone slabs, and could not make melted tin, lead and zinc extend in a cylinder four lines broad and two and a half lines deep, more than eight feet. But in this case the sandstone was cold, and we may suppose the melted granite to be hot, so that the injection might be extended indefinitely further. Bischof, however, says that like veins occur in stratified rocks. But according to his own views, these also, being metamorphic, might be equally hot. So that this argument does not seem to be of great force. And yet the great perfection of these veins does seem to us, in many instances, to agree better with the idea that water was the carrier of the materials into these narrow fissures, than dry heat. At any rate, we are satisfied that not a few of those granitic veins, that would be regarded by most geologists as veins of injection, had a different origin. But this is too extensive a subject to be gone into in this place, especially as the facts must be drawn chiefly from Massachusetts, though very similar to some in Vermont.

We cannot, upon the whole, but regard these new views of the origin of the granitic rocks as a decided advance upon those long held, and as giving a far more satisfactory explication of the phenomena. We understand the theory not to deny, but to admit, the igneous fluidity of the internal parts of the earth. But it introduces water, and by means of it, other more active ingredients, deep into the heated crust, and shows us how, by the conjoint agency of heat and water, those chemical changes which the rocks exhibit may have resulted at a lower temperature than has been supposed necessary, and in a more perfect manner. It does not decide how great a degree of heat may sometimes have existed, nor deny that the granitic rocks may sometimes have been injected and protruded in a plastic or a solid state. It is not the old Wernerian doctrine of the deposition of all the rocks, stratified and unstratified, from a universal ocean, and in continuous coats. And yet it may be regarded as a sort of intermediate theory between the Wernerian and Huttonian, and should teach us how the leading views of original minds, though apparently in conflict for a time, may at length coalesce.

AGE OF THE VERMONT GRANITIC ROCKS.

We judge of the age of the unstratified rocks—that is, of the period of their eruption—by that of the stratified rocks, through which they have penetrated. Hence, there is great difficulty in regard to the granitic rocks of Vermont, because the age of the metamorphic

strata in which we find them is so difficult to settle. We learn, however, some facts on this subject of no small interest.

1. It appears that in none of the fossiliferous strata of Vermont, that have not undergone powerful metamorphic action, so as to obliterate the fossils, is there any granitic rock, either as protruding masses or as veins. And we find, by consulting the geological reports of the different States, that the same is true through the whole Apalachian range. These are the oldest rocks known that contain fossils, extending from the Potsdam sandstone through the Devonian; yet nowhere have they been invaded by the granite till they have been so changed as to destroy the fossils. Still we know that granitic rocks have been protruded in other parts of the world at every geological period as high as the tertiary.

2. The same rocks, metamorphosed into slate, schist, and gneiss, have been also filled with veins and irregular masses of the granitic family. There has been no exception here, though, as we shall show below, some have more granite in them than others. Wherever we find rocks made slaty, schistose and foliated by metamorphic action, we may look for the granitic rocks; and the more thorough the metamorphism—that is, the more crystalline the strata, the more likely we are to meet with granite. We cannot resist the conviction, from what we have seen, that the most complete metamorphism produces fine granite, while a less perfect fusion may result in the other varieties of the granitic group.

3. The conclusion seems to follow clearly from these facts, that the production of granitic rocks is intimately connected with the metamorphism of the stratified. We do not say as cause and effect, but as joint products of the same general causes. We believe the internal heat of the earth to have been combined with water in both cases. But in the case of the granitic rocks, the heat was sufficient for entire fusion, while in the case of the stratified rocks, it was not sufficient to destroy all marks of original structure.

4. Though the slate, the schist, and gneiss of Vermont all contain granitic rocks, their amount is quite different. They are most common in gneiss and mica schist; less so, especially veins, in clay slate, and least of all in talcose schist. In this rock, indeed, our notes furnish us with but few localities; although this rock, as the map will show, occupies a large space in the State. Granite occurs as a bed in talcose schist, according to Mr. Hall, on the most northern section, in Newport; also, according to A. D. H., in Plymouth; also, according to C. B. A., in Braintree, Waterbury, and Lowell.

Shall we infer, from these facts, that the degree of metamorphism, or the age of the rock, decides the amount of granite? Perhaps both conclusions will stand, for the two things are usually correlative. All admit that clay slate is a newer rock, and less metamorphosed than gneiss or mica schist. Talcose schist has generally been regarded as older than clay slate, but our sections, almost without exception, represent it as lying above the slate, though both have usually a very high dip. It seems difficult to resist the conclusion, as we have stated in another place, that the schist is the newest rock. Perhaps the nature of its ingredients may have given it the appearance of a higher degree of metamorphism than the slate, for it is well known that the latter is very refractory under the influence of heat.

5. The facts elicited by our Survey, and that of adjoining territories, enables us to say

that much of the granite of Vermont is as recent, at least, as the Devonian period. To prove this we must refer to two localities a little out of the State, but connected with the rocks in it. We refer to the rocks at Owl's Head, in Canada, and in Bernardston, in Massachusetts, both of which we have fully described. Then there is the granite and limestone in Derby, sustaining, also, the Devonian age of the former. Nor can it be doubted that the breccia, or conglomerate—showing itself in several places in the Connecticut valley, between Canada and Massachusetts, and which has mostly been converted into some variety of granite—is at least as new as the Devonian—we think newer.

From these facts we can hardly resist the conclusion that all the granite of eastern Vermont is as recent as the Devonian. It occurs in the greatest abundance apparently protruded through the calciferous mica schist, which is not improbably of the age of the upper Silurian; but in some cases it also extends into the clay slate, whose upper part, at least, is proved, by the facts at Bernardston and Owl's Head, to be of Devonian age. Doubtless granite was produced in Vermont during the earlier geological periods down to the Potsdam sandstone. But when we find granite veins and masses in those lower rocks, it is not easy to prove that it does not extend upward as far as the Devonian, which is the latest known consolidated rock in the State. That is, the granitic outbursts that now appear in the lower rocks, may once have penetrated upward into newer strata, which have subsequently been worn away.

II. TRAPPEAN ROCKS.

With one exception, perhaps, these rocks occur nowhere in Vermont save in the form of dikes. The exception referred to is in Mount Holly and Clarendon, on the Rutland and Burlington Railroad, and quite possibly the masses of greenstone that appear for many miles in length along this road, may be only huge dikes. The rock here appears to be greenstone, that is, made up of hornblende and feldspar, although we have not been able to obtain any analysis of it, and this is becoming almost indispensable to distinguish the varieties of the trappean rocks. In this case, however, analysis would probably be of little service. "It appears to be quite vain," says Bischof, "to attempt a classification of greenstones. They constitute a series, the extreme members of which are, on the one hand, augitic porphyry, with distinguishable augite and Labradorite; and on the other, diorite or syenite with distinguishable hornblende. Between these opposite extremes there are innumerable intermediate varieties, with regard to which it is quite uncertain whether they are to be classed with augite or hornblendic rocks:" (*Chemical and Physical Geology*, Vol. III, p. 300.) Most of the greenstone connected with the azoic rocks of New England is a nearly compact, slightly greenish mixture of feldspar and hornblende. It is regarded as the equivalent of diorite on the continent of Europe. But some of our greenstones appear quite as much like dolerite. Indeed, we could find among our greenstones most of the varieties of German rocks analyzed under diorite and dolerite. In Vermont they are rarely vesicular, but sometimes, as at Newbury, Weathersfield, and Shelburne, they are concretionary.

We consider ourselves quite fortunate to have found, among the papers left by Prof. Thompson, a description with a map of all the dikes found in Chittenden county, where they are more abundant and peculiar than in any other part of the State. We give the paper entire:

DIKES OF CHITTENDEN COUNTY.

BY PROFESSOR THOMPSON.

The dikes in this county are exceedingly numerous, and vary very much in their composition and characters. While some of them consist of well characterized greenstone, others consist almost entirely of white or yellowish-white feldspar. Intermediate between these there are many which are more or less porphyritic, and some which are very well characterized porphyry. The whole number of dikes of all the different kinds examined in the county is about sixty, of which number all but four or five are in the Champlain rocks, and these four or five are in the Taconic rocks. None have been found in the primary rock along the eastern border of the county.

It may here be remarked that the greenstone, or trap dikes, are generally straight and of very uniform width, and may frequently be traced through a considerable distance. The feldspathic dikes, on the contrary, are often crooked and variable in width. The following Table exhibits the principal, though not the whole, of the dikes which have been observed in this county, with several important facts in relation to them. A more particular account of some of the most interesting dikes will be given further along.

NOTE. The dikes in the following Table are referred to on the Map, Plate 6, by numbers corresponding to the first column of numbers in the Table.

LIST OF THE PRINCIPAL GREENSTONE OR TRAP DIKES IN CHITTENDEN COUNTY.

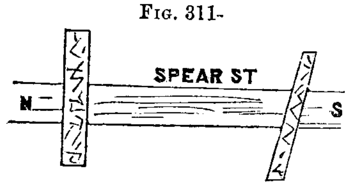
No.	*Direction.*	*Width.*	*Rock.*	*Locality.*
1	N. 70° W.	2 ft.	Silicious Limestone.	Burlington, Spear street, three-fourths mile southeast of University.
2	N. 70° E.	5 "	Silicious Limestone.	Burlington, Spear street, five rods north of No. 1.
3	N. 80° E.	12 "	Red Sandstone.	Burlington, Red Rocks, one mile south of village.
4	N. 90° W.	4 "	Red Sandstone.	Burlington, Willard's Ledge, one-half mile south of village.
5	N. 90° W.	7 "	Red Sandstone.	Burlington, one-fourth mile north of mouth of Potash Brook.
6	N. 90° W.	4 "	Silicious Limestone.	Burlington, near southeast corner, crosses Muddy Brook.
7	N. 90° W.	2½ "	Silicious Limestone.	Burlington, Dr. Spooner's pasture, one-half mile south of University.
8	N. 65° W.	1¼ "	Black Slate.	Juniper Island.
9	N. 74° W.	1 "	Black Slate.	Colchester, Clay Point.
10	N. 10° W.	1½ "	Black Slate.	Colchester, Stave Point.
11	N. 90° W.	2½ "	Blue Limestone.	Colchester, near Stave Point.
12		3 "	Silicious Limestone.	Essex, Hubbell's Falls.
13	N. 70° W.	5 "	Black Slate.	Shelburne, northwest extremity of Pottier's Point.
14	N. 90° W.	6 "	Black Slate.	Shelburne, a few rods north of ship-yard.
15	N. 85° W.	2¼ "	Black Slate.	Shelburne, twenty rods north of 14.
16	N. 85° W.	3½ "	Black Slate.	Shelburne, ten rods north of 15.
17	N. 10° W.	10 "	Black Slate.	Shelburne, fifty rods southeast of Nash's Point.
18		20 "	Black Slate.	Shelburne, west road from Harbor S.
19	N. 10° E.	5 "	White Marble.	Shelburne, east part one mile south of new meeting-house.
20	N. 80° E.	4 "	Red Sandstone.	Shelburne, one-half mile north of village.
21	N. 55° E.	1¼ "	Silicious Limestone.	Shelburne, one-half mile southeast of 19.
22		4 "	Black Slate.	Shelburne, one-half mile northeast of Nash's Point.
23		1 "	Black Slate.	Shelburne, Nash's Point under porphyry.
24	N. 87° E.	2 "	Magnesian Slate.	Williston, two miles southeast of the village.
25	N. 53° E.	5 "	Magnesian Slate.	Williston, southwest part.
26		3 "	Magnesian Slate.	Williston, near Muddy Brook, southwest part.
27	N. 80° W.	1 "	Limestone.	Williston, near Muddy Brook (Feldspathic, I think.)
28	N. 45° E.	3 "	Magnesian Slate.	St. George, three-fourths mile north of post-office.
29	N. 88° W.		Magnesian Slate.	St. George, a few rods north of 28.
30		2 "	Magnesian Slate.	Richmond, one mile west of meeting-house.
31	N. 90° W.	6 "	Black Slate.	Charlotte, Holmes' Point.

SOME OF THE FELDSPATHIC DIKES.

No.	*Direction.*	*Width.*	*Rock.*	*Locality.*
32	N. 50° E.	2½ ft.	Silicious Limestone.	Burlington, crosses turnpike one-half mile southeast of College.
33	N. 80° E.	6½ "	Red Sandstone.	Burlington, Red Rocks.
34	N. 10° W.	3 "	Red Sandstone.	Burlington, Bluff Point.
35	N. 10° W.		Slate.	Williston, southwest part near Muddy Brook.
36			Black Slate.	Shelburne, west of head of the Bay, on the road to S. B. Horner's.
37			Black Slate.	Shelburne, eight rods north of 36.
38			Black Slate.	Shelburne, eight or ten rods north of 37.
39			Black Slate.	Shelburne, one-half mile further north.
40			Black Slate.	Shelburne, near the school-house on Pottier's Point.
41			Black Slate.	Shelburne, east side Pottier's Point, forming two small points.
42			•	Shelburne, one-half mile north of 41.
43	N. 81° W.	2 "	Red Sandstone.	Shelburne, fifty rods northwest of Laplot River's mouth.
44	N. 90° W.	8 "	Black Slate.	Shelburne, twenty rods north of 43.
45	N. 4° E.	20 "	Black Slate.	Shelburne, shore east of Nash's Point.
46			Black Slate.	Shelburne, Nash's Point.
47			Black Slate.	Shelburne, Nash's Point.
48	N. 48° W.	23 "	Silicious Limestone.	Shelburne, one mile northeast of village.
49		8 "	Silicious Limestone.	Shelburne, thirty rods south of 48.
50		10 "	Black Slate.	Charlotte, Holmes' Point, one mile northeast McNeil's Landing.
51	N. 70° W.	6 "	Birdseye Limestone.	Charlotte, one-half mile east McNeil's Landing.
52	N. 75° W.	8 "	Birdseye Limestone.	Charlotte, one-half mile east McNeil's Landing.
53	N. 90° W.		Black Slate.	Charlotte, through south part of Glebe Hill.

(1, 2.) The trap dikes on Spear street (Fig. 311), in Burlington, are interesting on account of the effects produced upon the silicious limestone. These dikes are both seen in the road, which they cross as exhibited in the margin. The street runs north and south, and the strike of the silicious limestone cut by the dikes is in the same direction. Adjacent to the sides of the southern dike the rock appears to have been melted, or partially so, and in cooling to have arranged itself in plates parallel to the sides of the dike, giving it the appearance of being stratified in that direction.

Fig. 311.



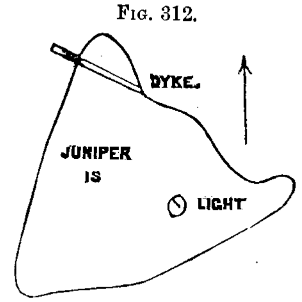
(4, 7.) The trap dike which cuts through Willard's ledge, is two and a half feet wide at the brow of the ledge. A few rods to the east it reäppears and is there four and a half feet wide, and the direction is such as to carry it across the locality No. 7, in Dr. Spooner's pasture near a quarter of a mile further east. Nos. 4 and 7 are therefore doubtless the same dike.

(6.) This dike appears on the west side of Muddy Brook, in the south east part of the town, on land of Mr. Owen, and may be traced a considerable distance eastward on the east side of the brook in Williston.

(3.) This broad dike, being twelve feet wide, is situated only twenty feet from a feldspathic dike, six and a half feet wide and running parallel with it.

(5.) This is about sixty rods west of the saw-mill nearest the mouth of Potash Brook. The dike is exposed for a considerable distance.

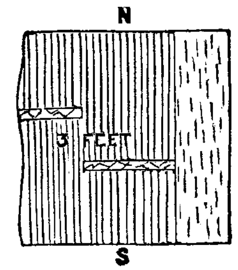
Fig. 312.



(8.) This dike (Fig. 312) passes entirely through the northwestern part of Juniper Island. This island lies three miles southwest from the wharves in Burlington, and contains about a dozen acres. The foundation of the island is entirely of black slate, and the surface, on which there is a good soil, is elevated from thirty to forty feet above the lake, with a perpendicular precipice of the same height on all parts, excepting a small portion of the eastern extremity.—This dike is fifteen inches wide, and its direction N. 65° W. On the northeastern side, at the foot of the precipice, there is a fault in the dike amounting to just its width.

(9, 10, 11.) These three dikes are in the same vicinity, and No. 9 only possesses any peculiar interest. This cuts through the slate near the extremity of Clay Point. It is only ten inches wide, and in it there is a fault of three feet, the eastern portion offsetting that distance towards the south, as in Figure 313.

Fig. 313.

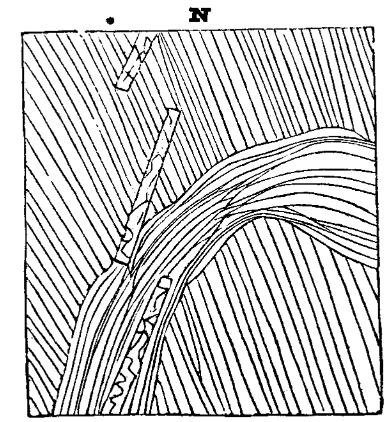


South of the dike the dip of the slate is nearly vertical, while on the north side it is about 74° W., showing that there was some dislocation of the strata when the dike was injected. The laminæ of the slate dip to the east.

(12.) The trap dike at Hubbell's Falls (Fig. 314), is seen in the bed of the river, and is interesting both on account of exhibiting several faults, and the diversity of the different portions of the dike in composition. This dike is about three feet wide, and its faults are exhibited in the annexed diagram. This is a very interesting locality. The slate and silicious limestone show that the disturbance was very great when the dike was thrown up.

(13.) The dike at the northwestern extremity of Pottier's Point, exhibits a sensible curvature in the distance of four or five rods which are exposed along the shore.

Fig. 314.



At Hubbell's Falls.

(14, 15, 16.) Nothing peculiar in their situation. No. 15 or 16 is probably the continuation of No. 13, exposed on the eastern side of the point.

(17.) This dike crosses the road running east and west about thirty rods east of Mr. Nash's house, and may be seen in the fields for some distance on each side. This dike, from the ochry appearance of its weathered surface, has been taken for iron ore, and on the strength of that erroneous supposition a considerable quantity of it has been dug out and lies exposed on the surface of the ground. It is in loose black slate and is divided longitudinally nearly in the middle by a compact stratum of slate six or seven inches thick. The dike on the opposite sides of this dividing stratum seems to be different in the manner of aggregation, one side being disposed to break into rhombic masses and the other into those which are rounded, or globular. The surface was not sufficiently exposed to allow me to trace this dividing stratum beyond a few feet.

(18.) This is a very large dike and has furnished materials for a considerable amount of stone wall, but was not much examined.

(19, 20, 21.) No. 19 is interesting on account of its exhibiting drift scratches, and 21 on account of numerous imbedded crystals.

(22.) This dike is very similar to No. 17, and is situated a quarter of a mile to the northeast of it and having a different direction. It is four feet wide and divided in the middle by a stratum of slate, eight inches wide.

(23.) At this locality there are two dikes beneath the porphyry, No. 70, which will be described in connection with the porphyry further along.

(24, 25, 28, 29, 30.) Are remarkable only for being found in the magnesian slate of the Taconic System.

(26, 27, 31.) These do not require any additional notice.

The Feldspathic Dikes are, as already stated, much more irregular than those composed of greenstone. These, with one exception, No. 25, are all confined to the south half of Burlington, and to the towns of Shelburne and Charlotte. They appear in greatest force on Pottier's Point, which is the peninsula extending north on the west side of Shelburne Bay.

(32, 33, 34.) The three dikes in Burlington, which are diverse from the greenstone, exhibit nothing worthy of remark, unless it be that one which crosses the Winooski turnpike, half a mile south of the University and in front of the farm-house of Carlos Baxter, Esq. This seems to differ from all the other dikes in composition.

(36, 37, 38, 39.) These are from three to five or six feet wide, are very similar, and all cross the road leading from the head of Shelburne Bay to the steamboat harbor, in the course of half a mile from the corner where that road turns to the north.

(40.) This is a very hard and singular dike, situated in the edge of a grove near the school-house on Pottier's Point. The road passes directly over it and it has furnished materials for a considerable piece of stone wall by the road side.

(41.) There are two interesting dikes at this locality a few rods apart. They form two projecting points on the western side of Shelburne Bay, situated about half way between the head of the bay and the extremity of Pottier's Point.

(56 and 57), in black slate. On the side, or rather the end of 56, the slate has been worn away down to the surface of the water, and the dike there seems to rise up through the slate in a rounded mass six or eight feet across, and the outer part, the exterior surface of which is an even, well-defined curve, is exceedingly compact and hard. The central portion, especially when acted upon by the weather, is readily loosened and comes out in jointed blocks. This dike rises as high as the slate which forms the precipitous bank, and which amounts to about twelve feet. Its extent into the bank is concealed by the overlying sand and soil. The other dike forms the extremity of the point 57. This point is almost separated from the main land by the action of the waves. It rises about eighteen feet above the water. This dike resembles in its structure No. 40, and may be a prolongation of it.

(42.) This dike forms a small projecting point, half a mile north of 41. It rises about ten feet above the water, and in composition bears some resemblance to 41 (57.) These dikes form projecting points on account of being less easily washed away than the slate.

(43, 48, 49.) These three dikes are very similar in color and composition. Their color is a bright chocolate where not weathered, and their texture fine and compact. The crystals of feldspar are scattered sparingly through the rock, and their color but little lighter than the general mass. No. 43 is in the red sandstone, and 48 and 49 in the overlying silicious limestone. No. 48, which is 23 feet wide, is exposed for a dozen or more rods, and has furnished most of the materials for a dozen or more rods of stone wall. May not this dike furnish materials for architectural purposes?

(44.) This dike is about twenty rods north of 43, in the black slate, at the foot of a considerable precipice of silicious limestone. It is a kind of breccia, being filled with small fragments of the black slate.

(45, 46, 47.) The porphyritic dikes at Nash's Point and vicinity are so numerous and irregular that I shall not attempt to particularize them. The whole surface of Nash's Point, embracing several acres, is strewed with fragments of porphyry, and it seems to be cut up by dikes traversing it in all directions. On the southeast side of Nash's Bay the bank is formed by a porphyry dike about twenty feet high, for the distance of ten or twelve rods. The slate has all been removed on the side next the bay, down almost to the surface of the water, and the dike stands out like a huge wall, about five feet thick, built to support the bank. But it must fail of that purpose. The waves have already broke through in two or three places near the base to the slate behind, and but few years will probably elapse before it will all come down with a tremendous crash.

One of the most interesting spots for examination at this remarkable locality is that denoted by *b* in the accompanying little map. The bank, which is here perpendicular and about 20 feet high, is composed of porphyry and black slate, and there is plain evidence in several places that the porphyry, while rising through the slate in a fluid state, before reaching the upper surface, lifted up the slate and flowed off laterally between the beds of slate. The bank, which forms the angle at *b*, consists at the top of soil and black slate perhaps two feet in thickness. Next below this lies a bed of porphyry about eleven feet thick, presenting a smooth perpendicular face towards the lake and extending horizontally several rods. Beneath this is black slate, which forms an irregular sloping surface down to the water, and along next to the water is covered with large blocks of the porphyry, which have fallen from the bank. Cutting through the black slate in an eastern direction are two parallel trap dikes which are directly beneath the porphyry, and must have been cut off by it, as is evident from the circumstance that fragments of them are found in the slate above the porphyry. Each of these dikes is about one foot wide, and they are some eight or ten feet apart. In one of them there is a fault amounting to just the width of the dike. The porphyry and the trap dikes at this place cut through the black slate beneath the porphyry. The dikes and porphyry are not joined together, nor fully in contact so far as I could examine, but the space between them, where there had been no removal of the dike by the waves, was a mere crack, which showed that there had been nothing interposed between them. From beneath the north end of the mass of porphyry, the waves have removed the slate for a considerable space, and here the under side of the porphyry has rounded protuberances, which appear as if formed by its sagging down when in a fluid state.

Along the east side of the point next to Nash's Bay the porphyry appears in numerous places, in some of which it appears to be thinly spread out between the layers of the slate, and in others cutting through it in the form of dikes.

(50, 51, 52, 53.) Most of the feldspathic dikes, as may be seen by the Table, are in the black slate, but two of those in Charlotte cut through the birdseye and Trenton limestone in the vicinity of McNeil's Landing; and that passing through Glebe Hill is very possibly a continuation of one of them."

The region embraced in Prof. Thompson's Map and description is undoubtedly more prolific of dikes, and in this respect more interesting than any other portion of the State. We shall add whatever additional facts have fallen under our notice.

The following sketch (Fig. 315) will give a more definite idea of the dikes at Nash's Point, where they are numerous and complicated; and we fear that longer study is necessary fully to unravel them.

A, is two and a half feet wide; course N. 53° E.; Dip 40° S. E. B, is thirteen feet wide; runs N. 50° W., perpendicular. At its east end, the rock around it has been worn away and it stands up as a wall, breached, however, in one or two places. Its composition is very interesting. Its walls, or outsides, consist of a rock of a dull whitish or brownish color, with disseminated feldspar crystals. It exactly resembles trachytic porphyry, and the feldspar crystals may be ryacolite, although, like the base, they have a dark aspect. The whole rock has the appearance of incipient decomposition, and analysis confirms this appearance by showing the presence of water. This porphyry is about two feet thick on the north side of the dike, and one foot on the south side. But the central part is occupied by a conglomerate, or rather breccia, for the fragments are not generally much rounded. Yet they are enough so to prove them water-worn.— The cement appears to be partly the same materials comminuted, and partly the base of the porphyry. The most conspicuous fragments are Utica slate, scarcely altered, and retaining its carbonic acid, so as to effervesce freely. Indeed, most of the fragments, except the quartz, effervesce slightly, as does also the base of the porphyry. The fragments vary in size from that of a pea to those four or five inches long. We recognized among them the following varieties: 1, Granite; 2, Gneiss; 3, Hornblende schist with garnets; 4, Quartz; 5, Grey sandstone; 6, Red sandrock; 7, Black (Trenton) limestone.

At B (Fig. 316), is shown a horizontal section of this dike. From this it will be seen that the breccia does not extend through its whole height.

Prof. Thompson, as quoted above, has described a dike near the south end of Shelburne Bay, on the west shore, and nearly east from that one we are now considering, and he calls it "a kind of breccia being filled with small fragments of the black slate." Its direction is east and west, and it may be the same as the one we have described; yet in direction they differ 40°, and probably they are distinct.

An important question arises as to the character of this and the other light-colored somewhat porphyritic dikes of Shelburne and vicinity. In appearance the rock can hardly be distinguished from trachyte, and the imbedded crystals, if not too dull, would readily pass for ryacolite, or glassy feldspar. We are indebted to Mr. G. F. Barker for an analysis of the base of the dike containing the conglomerate; and we have placed along side of it analyses of some other minerals and rocks for the sake of comparison.

	I. *From Shelburne.*	II. *Orthoclase.*	III. *Oligoclase.*	IV. *Trachyte.*	V. *Trachytic Conglomerate.*	VI. *Feldspar Porphyry.*	VII. *Andesite.*
Silica,	67.30	65.37	63.70	67.09	66.39	68.56	67.07
Alumina and iron,	19.10	20.47	23.64	20.22	22.71	19.55	17.93
Titanic acid,				0.38		Manganese,	0.32
Lime,	0.79	2.60	1.44	2.25	0.53	0.50	3.69
Magnesia,	trace		1.20	0.97	0.47	0.20	3.46
Potassa,	4.74	6.30	2.31	3.56	3.05	7.50	2.18
Soda,	6.04	4.00	6.15	5.07	1.94	2.62	4.90
Loss by ignition,	1.70		1.22	0.45	4.89		0.30
	99.67	98.74	99.66	99.99	99.98	98.93	99.85

In selecting the above analyses, those have been taken which approach nearest to that of the Shelburne rock. No. II. is common feldspar from Chili, analyzed by Domeyko; No. III. is oligoclase from porphyry in Belgium, by Delesse; No. IV. is the matrix of the Drachenfels trachyte, by Bischof; No. V. trachytic conglomerate, by Von der Marck, from Ofenkuhlen; No. VI, feldspar porphyry from a dike near Freiburg, by Kersten; and No. VII, andesite, a variety of trachyte, from the top of Pichincha, in South America, by Abich. To which of these now shall we refer the Shelburne rock?

We see at once that it is essentially a feldspar; but it differs from the common feldspar (orthoclase) in respect to the potash and soda, the latter being more than the potash in the Shelburne rock, and less in orthoclase. In the oligoclase from porphyry (No. II.) the soda predominates, as it does in trachyte (No. IV.), and in andesite, another variety of trachyte (No. VII.) In the feldspar porphyry the potash predominates as well as the trachytic conglomerates (Nos. V. and VI.) Upon the whole, the correspondence in this respect is strongest between the Shelburne rock and the trachytes.

As to specific gravity the Shelburne rock agrees essentially with both trachyte and feldspar porphyry.—According to Mr. Barker it is 2.60. That of trachyte varies from 2.578 to 2.689; and that of porphyry is 2.62. As the amount of silica in a rock decreases, the specific gravity increases in an inverse ratio. In the Shelburne rock the relation of these two characters is the same as elsewhere.

All will admit, then, that this rock is a porphyry, with a feldspathic base. But it is what is technically called trachyte or feldspar porphyry. In external appearance and texture it bears a strong resemblance to trachyte, and but little to feldspar porphyries, though somewhat resembling claystone porphyry. In chemical composition and specific gravity, also, it agrees best with trachyte. Indeed we should not hesitate to call it trachytic porphyry, were it not for the fact that trachyte has always been regarded as a comparatively recent volcanic product. We have not, indeed, been able to determine the period of its eruption. We have not found the dikes in rocks more recent than the lower part of the upper Silurian. But none more recent occur in the region of the dikes. They may once have existed and been swept away with whatever dikes they contained. We have been informed that Sir William Logan regards these dikes as of Devonian age; but on what evidence we know not.

One other fact ought to be mentioned as bearing on the question of age. At the extreme end of Nash's Point is a porphyrytic dike (E, Fig. 315) dipping 15° E., twelve feet thick. This has cut off two nearly vertical dikes from one to two feet wide of amygdaloidal trap, composed mainly of hornblende. This fact shows that the porphyritic dikes are the most recent; and it may be that they are the trachyte of those early days; or it may be that they are much more recent than has been supposed. We shall not hesitate to call this rock trachyte or trachytic porphyry.

The conclusions to which the conglomerate character of the dike, B, seem to conduct us will be noticed in the sequel.

O, is a porphyritic dike standing perpendicular and forming a wall one hundred feet long, twenty feet high, and seven feet wide, a little northwest of that just described. We noticed no conglomerate in this. It runs N. 50° W.

D, is five feet wide, and may be connected with D, D, to the right and left. An end view of one spot in this dike is shown on Fig. 317, where it shows an unusual curvature. Between D and D on the left the slates are a good deal disturbed, and run nearly east and west, almost at right angles to their normal course.

E, has been already referred to. It is twelve feet thick. On its east side it contains fragments of the slate, one of them two feet thick, having in it a small, segregated vein.

At F, beneath E, as already mentioned, are two dikes of hornblendic trap, cut off by E, and only one of them shows itself above E; but this is removed six feet laterally. The rock of these dikes seems to us to come near some of the European diorites, and it recalls a remark of the eminent chemist Rose, that "the age and general development of the American diorites seem not much to differ from that of the trachytes, while in other countries the diorites are much older and stand nearer to the granitic rocks." (*Simpson's Report on Utah*, 1858, page 62; *by Engleman.*

Fig. 315.

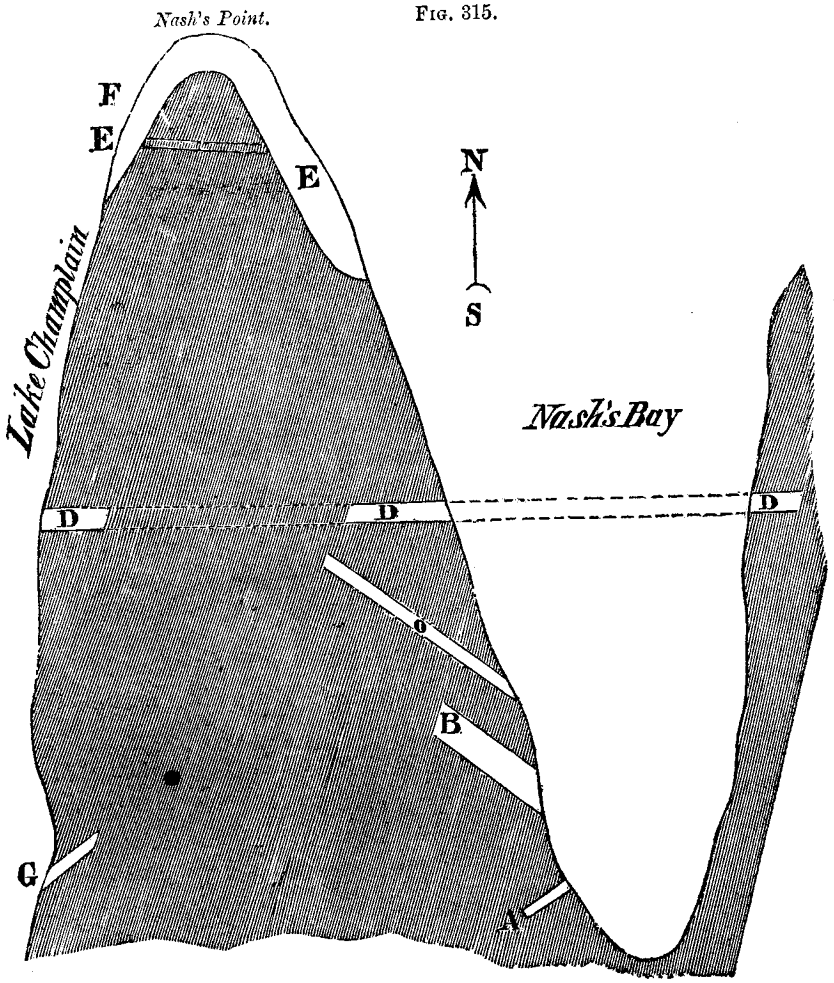


Fig. 316.

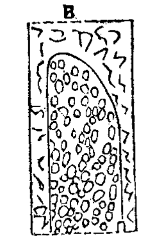
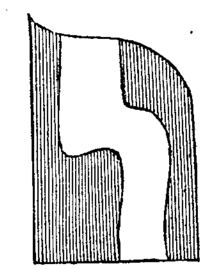


Fig. 317.



Dikes in the lower Hudson River slates, at Nash's Point, Shelburne.

OTHER TRAP DIKES.

In Hinesburgh, near the center, is a dike of porphyry seven and a half feet wide; course, N. 70° E.; dip, 90°; in the red sandrock series.

In North Ferrisburgh a porphyritic dike, five feet thick, runs N. 80° W., in Utica slate. Another in same place, 20 feet wide, in lower Hudson River slate.

In Waltham is a greenstone dike; course, N. 40° W; dip, 90°.

The following on islands in Lake Champlain, are of greenstone:

Law's Island, 18 inches thick, in Utica slate; N. 54° W.; dip, 80° E.
Law's Island, 9 to 18 inches thick, in Utica slate; west of the first.
Yew Island, in Utica slate; N. 40° W.
Stave Island, in Utica slate; N. 50° W.; four feet, eight inches thick.
Savage Island, southwest side—according to Prof. Thompson.

South Hero, south part, in Chazy limestone, N. 82° W., twenty inches.
South Hero, north of Sawyer's Bay, in Trenton limestone, three feet ten inches thick.
South Hero, N. 83° W., in Trenton limestone, two feet thick.
South Hero, N. 64° W., in Trenton limestone, ten inches thick.
South Hero, one mile below sandbar bridge, are two dikes, about one hundred rods apart, running nearly east and west.

Grand Isle, near the middle ; course, nearly east and west.

At Highgate Springs is a dike ten rods wide ; running N. 20° E., in Trenton limestone, perhaps of greenstone. Needs further examination.

In Prof. Thompson's notes we find it stated that "in Richmond are several trap dikes, running in an east and west direction. In Milton is a trap dike, four feet wide ; N. 65° E., in upper Hudson River slate. Near this *was a seven-sided basaltic column.*" This last fact is the only one of the kind ever noticed in Vermont, and it is to be regretted that Prof. Thompson's notes are not definite enough to enable us to look up the locality.

The following are given from Prof. Adams' notes :

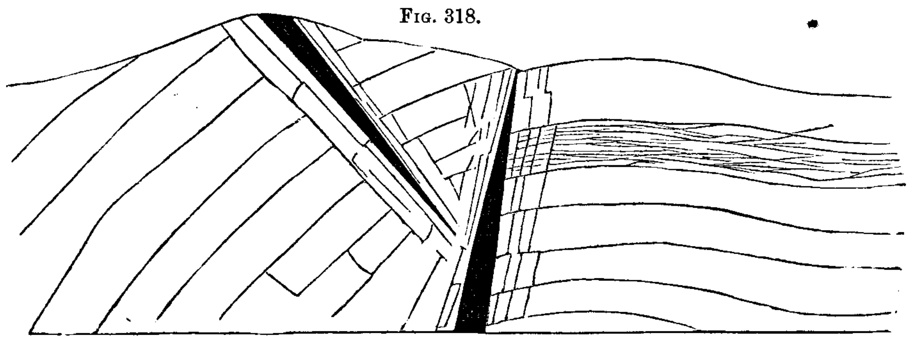
In West Rutland is a dike running nearly east and west, in Dorset (Eolian) limestone.
In southwest corner of Pittsford, east and west, in Eolian limestone.
In Stockbridge, northwest part, N. 60°W., in talcose schist.
In Bolton, southwest part, east and west, in talcose schist.
In Enosburgh, southwest part, N. 60° W., in talcose schist.
In Albany, southwest part, N. 20° E., in calciferous mica schist.
On the line of Bradford and Corinth, N. 45°W., in calciferous mica schist.

Other Observers.

Danby, Symington's Quarry, Eolian limestone, N. 35° E.; dip, 70° N.W.; four and a half ft. thick. (E. H., jr.)
Same place, N. 35°W., in Eolian limestone, six inches to twelve inches. (C. H. H.)
Same town, Fisk's Quarry, in Eolian limestone, N. 35° E. ; dip, 76° N.W., four feet thick (C. H. H.)

A. D. H. furnishes Fig. 318, showing two trap dikes in limestone, on Danby Mountain. Cracks in the limestone are shown along the sides of the dikes.

FIG. 318.



Trap Dikes on Danby Mountain.

E. H. jr. says in his notes, "In Danby, at the west extremity of Fisk's Quarry, are two dikes with three feet of marble intervening. One is three and a half feet thick ; the other fifteen inches. One hundred and twenty feet from the last is another, N. 35° E., dip, 80°W. Thirty feet west is another of irregular. and shape, but of larger mass. At another place still further west are two other dikes, whose strike is N. 35° E. N. 82° E.; dip, 54°W. Another dike was seen lower down the hill, about on the level of Symington's Quarry."

Danby, Kelly's Quarry, south end, in Eolian limestone, two and a half feet thick. Danby, Kelly's Quarry, north end, in Eolian limestone, one inch thick (C. H. H.)

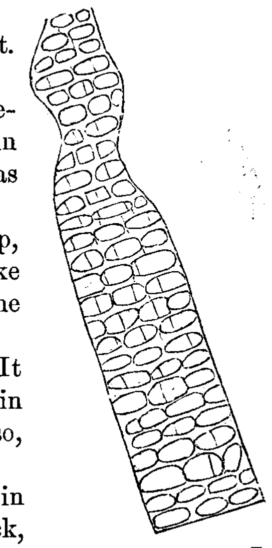
"A trap dike" (say the notes of E. H., jr.), "runs south from Sutherland Falls, N. 83° E. It is much decomposed, leaving a channel where it crosses the stream, and a valley across the railroad and pastures. Possibly it has a fork about twenty rods west of the railroad. Near the river the trap is very dark-colored, but in the pastures it has a pinkish hue. Another dike exists half a mile south."

The deep cuts in Mount Holly, on the Rutland and Burlington railroad have laid open the largest greenstone dikes yet found in the State. A. D. Hager's notes thus describe them : " Beginning at the west end, we have : 1. A Breccia dike, twenty feet wide. 2. Trap dike, thirty-six inches wide, dip, 65° E. 3. Greenstone dike, one foot thick. 4. Hornblende dike, eight paces thick. 5. Hornblende dike, nineteen

paces thick ; dip, 60° E. 6. Hornblende dike, twenty-seven paces, but only seven feet thick ; dip, 12°W 7. Dike of hornblende, fifteen paces wide." Hornblende schist exists at this place also, and perhaps some beds of this are compounded with the greenstone dikes in the above account. It ought to be added that several miles further west on the same railroad, in Wallingford, the widest greenstone dike in Vermont is crossed ; but unfortunately none of us have measured it. Those in Mount Holly are in gneiss and quartz rock.

Near the line between Mount Holly and Ludlow the turnpike passes through a dike of greenstone few rods thick, near the junction of gneiss and talcose schist ; though here the rock on the west side is quartz. In West Ludlow is a trap dike in talcose schist, N. 46° E., five feet thick.

FIG. 319.



In North Ludlow another, in quartz rock, dipping 80° E, eight feet thick.

Near the center of Warren is a greenstone dike, north and south, in talcose schist.

Another in Orange, south corner, in mica schist, three to four feet wide.

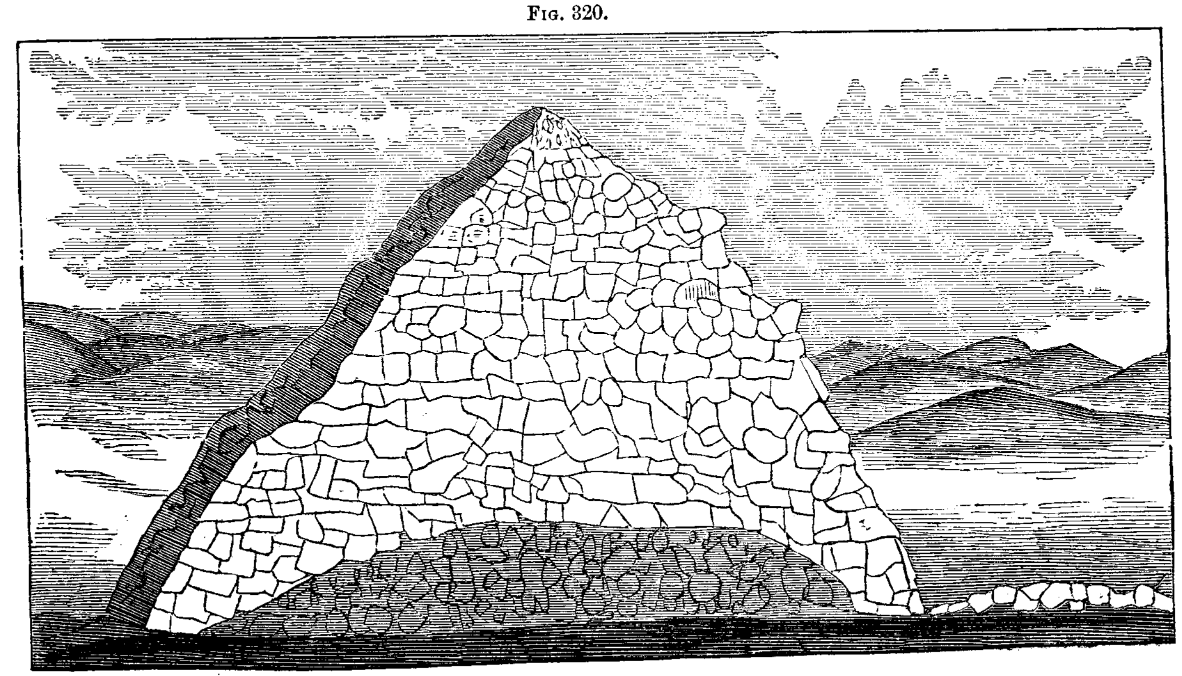
In Newbury is one, in talcose schist, 3 feet wide. This is made up of concretionary nodules, as shown in the adjoining sketch, eighteen feet high. It occurs in the railroad cut, two miles north of the village. The nodules seem to be in layers, as if made out of broken columns. (See Fig. 319.)

Near Quechee village is a greenstone dike, in mica schist ; course, N. 20° E.; dip, 58° E. Its width is five feet, and it is half a mile long. North of the river the dike has disappeared to a considerable depth, either by atmospheric decomposition or the action of the river, whose former channel may have been here. (C. H. H.)

In Weathersfield, at Craigue's Quarry, is a dike eight feet wide, in limestone. It shows itself twelve feet above the ground. Its course is N. 60° E. Another occurs in the same quarry, in limestone ; both, perhaps, branches of one dike. Here also, concretionary nodules are abundant.

A. D. Hager has found and sketched, on Fig. 320, a trap dike on Mount Eolus, in a marble quarry, which stands up as a wall above the surface. It is four feet thick, thirty feet long, and rises twenty feet above the surrounding rocks, which have been quarried away. It resembles a pile of wood, as seen from the west.

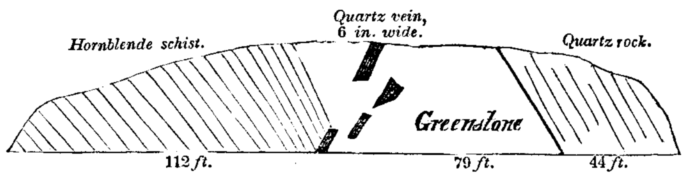
FIG. 320.



Dike on Mount Eolus.

In South Vernon, near the railroad station, is a section fourteen rods long, imperfectly represented in the sketch (Fig. 321.) On the left we have hornblende schist, highly micaceous, whose strike is N. W. and S. E.; dip 20°N.E. Next we have a trap dike whose dip on the lower side is 65°, and on the upper 60°, and whose width, measured along the surface, is seventy-nine feet. A vein of quartz in fragments and displaced, six inches thick, runs through the trap. On the righthand side the rock is quartz and perhaps compact feldspar.

Fig. 321.



In Waterford is a trap dike eight feet thick and one hundred feet high, extending half a mile in clay slate ; strike, N. 35° E. " Trap and granite dikes," say the notes of Prof. Thompson, "are common in the slate in the east part of Barnet. For the most part they follow the direction of the slate range. A narrow trap dike crosses the road a mile north of Stevens village. Width eight inches ; strike N. 32° E. Near the mouth of Passumpsic River is a trap dike four feet wide, cutting the slate range nearly at right angles, or E. 33° S."

In Brownington, east of the center, is a hornblendic dike running N. 85° E.

In Craftsbury a trap dike four feet wide crosses the mica schist at an angle of 15°. Another occurs west of the common, three feet thick. Another is seen on the common, three feet thick, running N. 10°W.

In Glover is a trap dike, in mica schist, two feet nine inches thick, whose strike is N. 60° E. with a northwest dip of 60°.

There is a trap dike, two miles south of Danville Green ; another eight feet wide, half a mile west of Stevens village in Barnet ; another in Barford, Canada East, with a northwest dip and strike of N. 40° E.; another half a mile northeast of Brownington village, N.46° E., two and a half feet wide ; another in Greensboro, fifteen inches wide. (Z. Thompson.)

CALCAREOUS DIKES.

A few cases of what we regard as dikes of limestone have fallen under our observation, and we regret that we did not, when at the localities, give them greater attention. Those which most particularly attracted our attention occur near the road leading from Brownington to Derby, only a mile or so from Brownington Center. Their course is N. 60° E. and one of them has a width of two feet.

In Professor Thompson's notes we find an account of a dike of a similar character. "At Concord," says he, " there is a very interesting dike in chlorite schist. It looks like magnesian limestone. It is near the house of Rev. Mr. Morse. It is about six feet wide. Its direction is N. 22° E., and it has been traced three miles. Its dip is 84° N. W."

DIKES AND VEINS OF OTHER SUBSTANCES.

Probably the most common veins are those of quartz, and they sometimes have the width and straightness characteristic of dikes. No rock in Vermont is desitute of them ; but they abound most in the crystalline rocks. Only a few cases have been described in our notes. We noticed one in the gneissoid quartz rock of the north part of Vernon as much as three rods wide, whose direction is N. 8° E. In Brownington they are numerous, from six inches to four feet wide. In Craftsbury we observed one in mica schist, four feet wide, and running N. 5° E. In some of the limestone in the western part of the State, we find the rock filled up with an interlacement of thin quartz veins, so as to make a complete network when the limestone has been disintegrated. They seem to be veins of segregation, as they rarely seem to cut one another off, but to coalesce where they cross. In the talcose schist of South Wardsboro is a dike of white quartz several feet thick.

But perhaps the most remarkable examples of veins are those of calcareous spar. One is struck with their great number and perfection. Nine-tenths of the rock, usually a limestone, are sometimes occupied by them. They occur in Trenton limestone, Utica slate and Hudson river limestone. Sometimes they

traverse clay slate, and then they cut the layers at right angles, and are of extreme fineness ; the calcite taking the form of satin spar, the fibers lying transverse to the veins. Often in this case it is surprising to see to what a degree of fineness they are reduced while they are perfectly straight. They become thinner than writing paper, as does the slate sometimes between them. Fig. 226 is a daguerreotype sketch of a pebble of this sort, picked up on the shores of Lake Champlain where they are common. In this case the veins are not as straight as in some others.

These veins are so abundant in some of the lower Silurian limestones that they gave rise to the name of Sparry limestone, which was supposed to be the characteristic feature of one particular variety ; but they abound in several varieties, and in localities too numerous to mention.

These veins form one of the chief elements of beauty in some of the Vermont marbles, as in some varieties of Winooski marble. Here the veins are very irregular, and abundant angular fragments of the red sandrock forming the basis of the rock are scattered through the calcite, as if broken off and floated into the matrix while this was in a fluid state. But by what agency or in what manner this could have been done, we find it very difficult to explain. In fact the theory of the introduction of veins into marble, if we go beyond general principles, is one of the most difficult in geology. We might multiply drawings almost indefinitely, and many of them would be very instructive if we had the means.

The numerous fragments of white carbonate of lime that give the chief beauty to the unique marble of Plymouth, are not veins, nor is it easy to satisfy ourselves what they are; but we strongly suspect that they may be organic remains, whose organism has been entirely obliterated by metamorphism.

DIKE OF LITHOMARGE.

In North Dorset is a dike, three feet thick, of lithomarge, in the Eolian limestone, running N. 30° E., with a dip of 90°. This substance is probably always the result of decomposition, sometimes from feldspar. In the present case the decomposition extends so completely through the dike, that we find no fragments of the original rock. Nor has the lithomarge been completely analyzed. Prof. Brush, of Yale College, and Prof. Shepard, of Amherst, have, however, satisfied themselves that it is a hydrated silicate of alumina, containing from three to four per cent. of carbonate of lime, and 19.33 per cent. of water, of which last, however, only thirteen per cent. is in chemical combination. It is now dug out for paint. The dike can be traced half a mile. The dike was originally porphyritic ; for when cut through, the implanted minute crystals, entirely decomposed, show themselves of a white color, being probably converted into kaolin. A second dike has lately been found at the same place.

METALLIC VEINS.

These are essentially the same as the veins and dikes that have been described, except that metallic matter is disseminated through the matrix,—which is the matter, whatever it be, that fills the vein. Much might be said on this subject, which mining experience has brought to light. But the mines that are worked in Vermont are so simple, that details derived from other mines would be of little use. The Vermont ores, however, more frequently occur in beds than in veins, and these are more simple still, being merely interstratified layers of rock containing metals.

ORIGIN OF VEINS AND DIKES.

The prevailing opinion has been that veins and dikes have been formed either by segregation, when the whole rock was in a plastic state, or by subsequent injection of matter from beneath, melted by dry heat, as cracks are now filled by lava in volcanos. Both these sorts of veins do undoubtedly occur. But the doctrine that all of them can be referred to these two classes we cannot adopt. In treating of granitic veins we have already intimated that some other agency must have been concerned in their production ; or rather that they must have resulted from heat and water. Dikes of porphyry and greenstone have been regarded as affording still more decided evidence of simple igneous origin. But some of the cases we have detailed are explained with far greater probability, if we admit the presence and agency of hot water. Indeed, if we admit nothing but dry heat, such cases as the brecciated feldspathic dikes of Shelburne are entirely inexplicable. That case has many difficulties on any theory; but it teaches some conclusions of importance.

1. It shows that the heat concerned in the production of this dike could not have been great enough to melt fragments of the lower Silurian rocks, or azoic rocks. We have seen that the breccia contains fragments of granite, gneiss, probably Potsdam and red sandstone, and Utica slate, which are unmelted and apparently not powerfully acted on by heat.

2. The heat must have been below redness,—that is, below 1000° of Fahrenheit; otherwise the carbonic acid of the Utica slate would have been driven off. But that rock does not appear to have been scarcely at all affected. A red heat must have expelled the carbonic acid. One would think it must have been considerably lower than a red heat.

3. Yet some agency must have softened the sides of the dike so as to allow chemical affinities to convert them into feldspar. Hot water would do this at a heat below redness, and that was most probably the agency.

4. A difficult inquiry arises, how this dike came to be filled with somewhat rounded fragments of the rocks in the vicinity? It is certain that they could not have been injected from beneath by melted matter tearing them off from the rocks through which it passed; for to say nothing of the improbability that a dike should pass through so many rocks and tear off fragments from them all, so as to bring them all together in one place, they have the aspect of water-worn pebbles, though not much rounded. One cannot resist the conviction that they must have been introduced from above. If so, what else but water could have done it? Suppose a crack to be formed in the strata at the bottom of a hot ocean: its waters would not only enter the fissure, but by means of waves and currents might drive into it the fragments of different rocks that had accumulated on its bottom. If this is not the mode in which the work was done, we have no theory to account for it.

As to the origin of quartz veins and dikes, there are great difficulties. The great difficulty of melting pure silica, especially such large quantities as some of these dikes contain, seems to forbid the supposition of injection by simple fusion. But, on the other hand, we can hardly see how such large masses should be precipitated from water. Yet, as silica is soluble in water, we can see how at least the small veins might thus be produced. Nor is the fact that slides of several inches often seem to have occurred during the process, an insuperable objection to this view. It does show, however, that the rock was solid enough during the process to allow cracks to be formed in it. Many of the smaller quartz veins, however, do not cut one another where they cross, and must, therefore, be segregations from the walls, when the rock was in a plastic state.

The origin of the veins of calcareous spar in the wet way is still more probable,—for the idea that if injected from a melted state they should retain their carbonic acid, is absurd. But we know that carbonates are formed from aqueous solution. The solution may have been, and probably was, aqueo-igneous; but the water was the essential agency.

As to those cases where we find angular fragments of the containing rock, floating, as it were, in the irregular veins of calcareous spar, the inference seems fair that the whole must have been in a semiplastic state. But by what agency the fragments could have been broken off and then suspended in the spar, it is difficult to conceive. Yet, for the reasons above given, viz., that the carbonate of lime was not decomposed, we cannot suppose fusion from a dry heat. And here, too, the rocks must have been solid enough to allow of fracture; for we frequently find quite large faults or slides cutting off the veins.

Metallic veins may have originated, for the most part, in the same manner as those above described, at least so far as the matrix is concerned. But some suppose, and not improbably, that sometimes galvanism and sometimes sublimation may have been concerned in introducing the metals.

If any should conclude, from the views we have now expressed, that we should admit water as more or less influencing the formation of almost every vein and dike, even in volcanic regions, we should not object. For it is well known that aqueous vapor, almost pure, issues in immense quantities from the crater in every volcanic eruption. Streams of mud, also, called moya in South America, are often poured forth in large amount, and in one case (in Java) a river of dilute sulphuric acid, mixed with mud, flowed over the country. From the streams of common lava, also, vapor escapes in large quantities, and it is not till this has been extricated that the lava will cool. From these facts it has been inferred, with strong probability, that the liquidity, even of common lava, is not owing to dry heat, but to the presence of water, so that even this is an example of aqueo-igneous fluidity. It may be difficult to account for the presence of so much water in lava; but we must admit the facts, whether we can explain them or not. And if even lava owes its formation in part to water, how much more probable that it was a controlling agent in all the older unstratified rocks, where the crystallization, very imperfect in lava, is more and more developed to its culmination in granite.

THEORY OF SUPERINDUCED STRUCTURES.

We refer to cleavage, foliation and joints. The first two occur only in stratified rocks, the latter in both the stratified and unstratified classes. Hence this is the proper place to say a few words about their origin. The concretionary structure, which exists in both classes, has been already described.

JOINTS.

Joints penetrate both the stratified and the unstratified rocks, generally in parallel planes, dividing the rock into rhomboidal masses, from a few inches to many feet in diameter. Their surfaces are generally smoother and more even than the planes of stratification.—This is seen more strikingly where the joints cross pebbles of quartz. These are often divided as neatly and evenly as if cut through when in a plastic state by a sharp and smooth knife. Indeed, we have seen masses of compact, homogeneous quartz, two or three feet in diameter, cut through in this manner. And in such cases we have never seen evidence of any sliding motion, so as to remove one half of the pebble from the other, but the parts remain perfectly *vis a vis*, or opposite.

Many distinguished geologists at the present day are inclined to regard all joints as the result of mechanical agency, either of shrinkage or fracture. These causes seem to us quite insufficient to explain the phenomena. Not a few fissures occur in rocks, having rough surfaces, and are not parallel, and these may be due to shrinkage and a strain, either vertically or laterally. And we think that shrinkage does produce sometimes, though not always, the columnar structure. But we doubt whether the irregular cracks above noticed ought to be regarded as joints, which it seems to us always have a position more or less parallel. Such certainly is the character of the most common and perfect, and how these, often only an inch or two apart, could have been the result of shrinkage, or tension, we cannot conceive. Especially we do not see how shrinkage could form smooth and almost planished surfaces. For to draw apart portions of a rock in a plastic or semiplastic state, must leave the surface more or less jagged; nor would the shrinkage planes run parallel over wide surfaces, as they often do.

In the Final Report on the Geology of Massachusetts (p. 418), we have given a description and figures of very perfect joints in unconsolidated alluvial clay, on the banks of Connecticut, Westfield and Deerfield Rivers. They occur in the banks of the stream, near the low water mark, and are underlaid and overlaid by layers of clay without joints. They are abundant at the localities. Now this clay has never been subjected to any pressure except the superincumbent alluvial layers; nor has it been disturbed at all, and probably has never been dried or made more plastic than clay would be by deposition in quiet water. Yet the joints are as perfect as any we have ever seen in the older rocks: being doubly oblique prisms, with angles varying from 60° to 89°.* To explain the origin of these joints we cannot call in the aid of any such divellent force as shrinkage, nor high temperature, nor pressure, nor fracture. They must have resulted from some such polar force as galvanism, acting upon layers of clay somewhat wet, but at the ordinary temperature of the atmosphere. Quite as difficult is it to explain, without a polar force, those joints which cut so neatly across quartzose conglomerates. In fact, though mechanical agencies may explain some joints, most of them seem to us to be inexplicable without the aid of some polar force. They seem to have been formed at all periods from alluvium to the oldest metamorphic formations. And a slightly plastic condition of the materials seems to have been the only essential condition.

CLEAVAGE.

Such a counterpart to cleavage is found in the ice of glaciers, where it has been subject to severe pressure in passing through gorges, that some distinguished geologists suppose pressure to have produced the cleavage of slate. Moreover, it is found that fossils in slate are often lengthened in the direction of the cleavage, and contracted in the opposite direction. Hence Prof. Phillips and Mr. Sharpe attribute cleavage to the action of great forces of compression. "Mr. Sorby, also, found, by microscopical examination, that the minute particles of clay slate were either lengthened in the direction of the cleavage planes, or that those minute particles, which were of unequal dimensions, were so re-arranged as that their longer dimensions coincided with the planes of the cleavage."

*See specimens in Nos. 1516 and 1683 of the Mass. Col. of Rocks in Amherst College.

The facts which we have stated as to the elongation and flattening of the quartzose conglomerates of Rhode Island and Vermont, give strong probability to the opinion that metamorphic rocks in general have been subject to powerful compression while in a plastic state. And we can hardly doubt that this mechanical force has been a leading agency in the production of cleavage. But the close resemblance of cleavage to joints, especially where there are two sets of cleavage planes, lead us to doubt whether some polar force—denominated crystalline action by Prof. Sedgwick, Sir Roderick Murchison, Sir John Herschell, Sir Charles Lyell, and others—has not been concerned; especially when we find that slaty cleavage often passes insensibly into the schistose or foliated structure, which mere mechanical compression cannot explain. Certainly the cleavage planes in Vermont must have been subsequently disturbed in order to give them their present dips. In the west part of the State the cleavage dips are so small, generally, that we cannot conceive how any strong compressing force could have been exerted at right angles. Consequently the layers must have been either in a more tilted position formerly, or the crystalline force must have been chiefly concerned in the work. In the clay slate ranges east of the Green Mountains the cleavage dip is usually higher. In another place we have shown that the average strikes of the clay slate scarcely differ from the general strike of the ranges.

FOLIATION.

In describing the flattened and elongated conglomerates, we have shown one mode in which even those coarse rocks may have been converted, by the joint agency of mechanical force and chemical action, into the folia of the schists. Every step of the process may be traced at Wallingford and Plymouth. We have seen how even gneiss may be formed, probably by the interpolation of feldspar, between the folia of mica. The conversion of the cement of the conglomerate into mica and talc, seems in the same rock to have been a still easier process. Indeed, if any sedimentary rock be permeated by hot water containing the requisite ingredients, why may not mica, talc, chlorite, feldspar, or hornblende be formed, so that we should have all the ingredients of the foliated rocks, except the layers or grains of quartz, and these surely might be the residuum from the decomposition of the silicates, which would take place in the formation of the other minerals. We do not suppose that all the foliated or schistose rocks were formed out of conglomerate; but its transformation, if we have rightly interpreted it, gives us a clue to the process in all other cases. Yet we by no means profess to be able to solve all the cases of foliation found in the rocks.

SEGREGATED VEINS.

Every geologist is familiar with that reticulated appearance which many rocks exhibit by the projection of narrow ridges of their harder parts, which resist the action of disintegrating agents more than the spaces between them. These ridges often run in various directions, not cutting one another, but fusing where they cross, so as to produce a kind of net work. We had always supposed that this must have resulted from the segregation of the particles along certain lines, when the rock was in a plastic condition. We were surprised, therefore, to find this same appearance on a cliff of sand and gravel in North

Dorset, which had been laid bare by the wind and rain, as already described and figured on Fig. 45 of Surface Geology. It needed only consolidation and a crystalline structure to be an exact representation of those metamorphic schists that abound in segregated veins.

Now these beds of sand and gravel were deposited in water, and were, of course, in a semiplastic condition while beneath the water. They must have been sufficiently so to allow the segregating process to go forward to some extent. As such cliffs ordinarily crumble down, the segregation would not have been manifest. But it so happened that the weathering of the surface in Dorset brought it to light, and we can readily believe it to exist in many alluvial deposits where it is not suspected. The same process may indeed have been gone through after the consolidation of the materials when they were subsequently made plastic; but it is interesting to find that the work may have commenced with the earliest mechanical deposition of sand and gravel. There too, as we have shown, very perfect joints were formed. Thus we can trace back to alluvial deposition two phenomena, which geologists generally have supposed to require heat nearly sufficient to melt the rocks *in situ.*

PART V.

NOTES ON THE SECTIONS.

BY C. H. HITCHCOCK.

The distinctive feature of the Vermont Geological Report lies in the Sections which are given in Plates XV, XVI, and XVII. The conduct of the Survey and the arrangement of the specimens in the State Cabinet at Montpelier, were regulated by them. The routes of the Sections are given upon the Geological Map.

As the formations in Vermont mostly run north and south, we could conceive of no better method of exploring them, than to cross the strata at right angles at intervals, and then compare the results upon the different Sections with one another. Accordingly this plan was adopted at the very first, and most of the explorations have been along these lines. We shall now present briefly the facts relating to the position of the rocks upon each one of these Sections, without drawing any inferences from them. We present the facts without any theories. We do not suppose the existence of faults, except in three or four cases where the evidence for disturbance is irresistible. We prefer, at present, to keep within, rather than overstep the bounds of the truth. We do not wish to state anything which the progress of science will show to have been premature.

We present the facts for study. For this reason we have arranged the Cabinet to correspond with the Sections. The specimens collected upon each section are arranged by themselves, and are numbered to correspond with the printed Catalogue. The whole of the south side of the room is occupied by the specimens and paintings of the Sections. For instance, Section I. occupies the shelf nearest the floor, the outline of the Section being painted on the wall behind the specimens. Upon the second shelf from the floor may be found the specimens illustrating Section II, with the outline of the Section upon the wall behind. In like manner the third, fourth, etc., shelves support the specimens illustrating Sections III, IV, etc., while the outlines are presented upon the wall behind the specimens. Hence the south side of the Cabinet is like a great map of the State.—The most northern section is at the top, the most southern section is at the bottom; and the specimens on the right hand side are from the western, and those from the left hand side are from the eastern parts of the State. We really know of no better way to *read* this part of the Report than to go to this Cabinet and study the specimens in connection with the painted outlines.

The base lines of all the Sections is the ocean level. The colors correspond to the tablet upon the Geological Map, Plate I. We give the town lines beneath the Sections in every case but one. The Sections are arranged upon the Plates in the same geographical order as in the Cabinet. For comparison we have given a section across the northern part of Massachusetts, west of Connecticut River. It was measured previously to our connection with the Vermont Survey.

SECTION IN MASSACHUSETTS.

This section commences in the west part of Greenfield, and extends to the western State line, through the towns of Shelburne, Charlemont, Rowe, Florida, Adams, and Williamstown. It is thirty-six miles long, and is represented upon Plate XV, beneath Section I. of Vermont.

The first rock which we encounter is the Connecticut River sandstone, which is not found in Vermont. It dips about 40° E., and overlies unconformably the calciferous mica schist. A part of this schist may hence be obscured, so that we do not discover its eastern limit upon this section. The first ledge seen exhibits strata running N. 10° E., and dipping 67° E. It is penetrated by two systems of joints, one running E. and W., dipping 70° N. (which is the most common system in the whole formation), and the other dipping 26° W. About two miles east of Shelburne Church the rock becomes hornblendic, running N. 20° E., and dipping 52° E. A mile further west the dip is 40° E. This rock is mica schist alone, without any associated limestone. This belt of rock extends about one and one-third of a mile, to the top of East Mountain — the high mountain east of Shelburne Falls.

Just below the top of East Mountain, upon its west side, we find about fifty feet thickness of hornblende schist, dipping 28° E., and under the mica schist. Passing down the mountain we find gneiss, at first dipping about 25° E., but becoming horizontal at Deerfield River. It is difficult to draw the exact line of demarkation between the hornblende schist and gneiss. In a quarry of gneiss west of the village of Shelburne Falls, the strata dip 12° N.W. The dip gradually increases for half a mile at a bridge over Deerfield River, where the dip is 45° W., and the strike N. 10° W. There have been disturbances in the gneiss in this vicinity, for, a few rods below this bridge, on the south branch of the river, the strike is N.W. and S.E., while the dip is 25° E. Many ledges are laid bare by the river, so that one can trace out immense curves of the strata. This is the locality from whence the specimen represented in Fig. 4 was taken. The gneiss extends to the church at East Charlemont. The following are a few observations upon the dip and strike of the strata in an ascending order: Dip 61° N.W., strike N. 70° E.; dip 30° E.; dip 80° W., strike N. 15° E.; dip E., strike N. and S. (local); dip 59° E., strike N. 30° E.; dip 40° W., strike N. 20° W.; dip 30° W., strike N. 10° E. The gneiss is exposed along the valley of the river, while the hills are capped with hornblende schist. The schist is crossed on the section at the church in East Charlemont, dipping 34° W., and running N. 20° W. This band of schist is the same as that on the top of East Mountain, but it lies upon the west flank of an anticlinal axis. West of the hornblende schist we find first the mica schist, and then the calciferous mica schist, in the reverse of the order in which we found them east of Shelburne Falls. The structure of this anticlinal is illustrated better than can be done by description, in Fig. 110, *bis*.

The mica schist, at one place where it is beautifully exposed, west of the church, dips 54° W., and runs N. 10° W. Its inclination gradually increases, till at the village of Charlemont it stands upon its edges. Here it joins talcose schist, the former having the strike N. 30° E., and the latter running N. 10° E. The strata of calciferous mica schist on the west side of the anticlinal are twice as thick as those upon the eastern side.

The talcose schist occupies about two miles of the section. Its dip varies from perpendicular to about 80° E. In many places it is hornblendic. It is replaced by mica schist— the formation which changes to feldspathic mica schist and gneiss in Vermont. The dip is about 75° E., as far as the east end of the Hoosac Tunnel. There are two beds of steatite, and one of serpentine, in Rowe, east of the Tunnel. At the east foot of Hoosac Mountain, at the east end of the Tunnel, the rock is talco-micaceous schist, dipping 77° E. Upon the east part of the top of the mountain the dip is 22° E., and the strike nearly N. and S.

The west part of the top of Hoosac Mountain is composed of gneiss, though there may be mica schist west of and beneath it. Near the Mountain House there is a change in the position of the strata, probably of a local nature. The strata here dip about 40° W.

It is difficult to know the precise nature of the position of the mica schist of Hoosac Mountain, in reference to the Eolian limestone of Adams, because their line of junction is everywhere obscured by drift. The west end of the Tunnel may decide this question, as soon as the excavation shall have penetrated through the limestone into the mica schist. Most probably there is a fault between these rocks, and we have so represented them upon the section.

The strata of limestone at the west end of Hoosac Tunnel have been greatly disturbed. Water has penetrated through the joints also, and has dissolved a large part of the rock, so that the masses of rock between the joints fall down as soon as an excavation is made beneath them. It is for this reason that the work of excavation at the west end of the Tunnel has progressed so slowly. Hence, also, it is difficult to ascertain the true dip of the strata. They appeared to us to lie nearly horizontal at the mouth of the excavation, and to dip 40° W. at the distance of 340 feet from the entrance, where the limestone becomes micaceous.

We suppose the true position of the Eolian limestone in Adams and the talcoid schists of Greylock, to be exhibited best at South Adams, a little south of the line of the section. At the "Harbor" in South Adams there is an exposure of mica schist running N. 47° E., and dipping from 35°–40° W. It forms an anticlinal, for to the east it is found lying nearly horizontal, and then it is succeeded by overlying limestone dipping 25° E. North west of the Harbor towards Greylock, the limestone appears, dipping under the mountain from 10°–30° W.

All the limestone does not dip west between the Harbor and the talcoid schists. Near the village of South Adams (west of it) it dips 20° E.; but the most western edge of it dips 80° W., near a cascade. The talcoid schists are first seen here, and they dip 80° W. Between the cascade and the top of the mountain the dip is generally from 75°–80° E. On top of the mountain the strata run N. 30° E., and dip 60° E. Upon the top of an eastern spur of Greylock, further to the north, the strata of talcoid schist dip west. Hence, we are inclined to the opinion that the structure of Greylock (or Saddle Mountain, as it is often called) is that of a synclinal axis: but it is a sharp synclinal, and occasionally the force which bent the strata has given them an eastern inclination. Without doubt the strata upon the west side of the mountain dip to the east.

At the "Little Tunnel" in North Adams there is a thick bed of talcoid schist — independent of the schist of the mountain — unless there has been a great disturbance; it dips sou ea 65°. The limestone south-west of it corresponds in position to this schist, underlying it.

In the valley north of Greylock, and north of the line of the section, the rock is entirely different. It is quartz rock. It is not yet settled whether this quartz rock underlies the limestone of Greylock or not; though we think the evidence is leaning to this view. The dip of the quartz rock is obscured, and several sets of divisional planes in it greatly perplex the observer. But quartz rock appears at the west base of Greylock, underlying both the Eolian limestone and the talcoid schist. Whether it is identical with the quartz rock in the valley of Hoosac river remains to be proved. Professor Emmons regards them as identical, and we have no objections to the view. In the South part of Williamstown another band of limestone appears dipping beneath the quartz rock. It dips 27° E., and runs N. 25° E.

West of this limestone we find the talcoid schists, running N. 20° E., and dipping 45° E. The question whether the schist is newer or older than the limestone has already been discussed. Much light is needed to clear up the obscurities of the relative position of all these rocks in Adams, Williamstown and Clarksburgh.

This section was measured by the Principal of the Survey in 1856, before his appointment to the Vermont Survey. The specimens illustrating it are in the Cabinet of Amherst College.

SECTION I.

The first Section in Vermont commences at the south-east corner of Vernon, and extends through the most southern tier of towns, near the Massachusetts line. It passes through Vernon, Guilford, Halifax, Whitingham, Readsboro, Stamford and Pownal. It is 41.5 miles long, and is represented upon Plate XV.

We find, at the extreme southeast corner of the State, hornblende schists associated with gneiss and mica schists. At Vernon Center the gneiss becomes so compact and jointed that it is very difficult to distinguish it from granite, and, at times, from syenite. At South Vernon depot the dip is 20° N.E. Next, a band of mica schist, containing chiastolite, dips 55° E. This belt has been traced into Bernardston, Massachusetts. The granitoid gneiss lies mostly west of this band of schist, and curves in conformity with a belt of schistose arenaceous quartz rock, which enters Vernon from New Hampshire, near the north line of the town; runs nearly parallel to the west line of the town, till in the southwest corner it makes a bend of nearly 90°, and passes into Massachusetts near South Vernon depot. The gneiss invariably rests upon the quartz rock, and is, therefore, newer. Both are probably of Devonian age, the quartz rock being the same that is associated with the Bernardston (Mass.) limestone, which is referred to the upper Helderberg. The gneiss and quartz rock appear to run into each other insensibly. The gneiss is best exhibited in several cuts upon the railroad south of Vernon depot. Both rocks occupy a basin-shaped valley, upon which the terraces of Connecticut River are found in great perfection. The best exhibitions of the quartz rock are upon the road between Vernon and Brattleboro, where it is seen to form a continuous range of small elevation. At its northern extremity two interesting dikes of blue hyaline quartz occur, one five feet and the other two or three rods wide. The character of the quartz is best seen at a place

where it was quarried for the manufacture of glass, about a half mile northwest of Burrough's hotel. The usual dip of the rock is from 30°–40° E.

The quartz rock rests upon clay slate unconformably in the west and north parts of Vernon. At the junction in North Vernon the clay slate appears to have a westerly dip of about 50°, while the quartz dips 25° E. Perhaps the dip more common to the slate at the junction of the two rocks, which, except at this point is covered by alluvium, is about 70° E.

This clay slate forms the range of hills in the west part of Vernon, turning eastwardly in the south part of the town. Before reaching the slate quarries of the Brattleboro and Guilford and New England Slate Companies, an anticlinal axis is passed, both of the sides being very steep. South of the quarries is a large vein of a compact variety of granite, a rock composed of compacted grains of quartz and feldspar. An occasional stratum of impure limestone, like that associated with the calciferous mica schists, has also been observed near the granite.

West of the slate quarries is a large amount of novaculite, a compact *mineral*, perhaps, considered by many as a variety of clay slate. There is also an immense tubercular mass of hyaline quartz near the quarries, eight rods long and four rods wide. We passed northwest to Algiers, from the quarries — a part of the way over a wide terrace, the highest upon Broad Brook. Here we found mica schist interstratified with numerous beds of impure bluish-gray limestone. The eastern limit of the formation we have called the calciferous mica schist, which has been suggested by Sir William E. Logan to belong to the upper Silurian system, and is, perhaps, equivalent to the Niagara group of the New York surveys. The dip at Algiers in only 55° E. In passing to Guilford Center the strata have a higher inclination to the east, and are mostly clay slate. Two miles east of Guilford the strata are vertical, with the strike of N. 20° E. In Guilford Center the strata have a less inclination to the east, and at about one and a half miles west of Guilford there is another anticlinal axis. Of course, between these two anticlinals there is a synclinal axis, which may be noticed upon Section I, in Plate XV.

The structure of the anticlinal west of Guilford deserves attention. Hornblende schist occurs upon the east side of the anticlinal, but the west side is so covered with soil that the character of the rock cannot be seen. But at Shelburne Falls and Charlemont, in Massachusetts, a similar anticlinal is very finely developed; and the relations of the different kinds of rocks are well determined. It was found that gneiss lies at the bottom or center of the anticlinal, covered on both sides by hornblende schist, which is in turn covered by mica schist, at first deficient in limestone, but subsequently containing the usual amount in the calciferous mica schist formation. So far as could be observed, the same succession of rocks is found at Guilford, and therefore we have supplied gneiss in the section beneath the hornblende schist.

Descending into the valley of Green River, we find the strata, which at first dipped 25° W., rising to 40° W. and 50° W. They continue to rise west of the river, and in the east part of Halifax are nearly vertical. Here also the beds of limestone have nearly or quite disappeared, and the mica schist is filled with garnets. The strike continues invariably N. 20° E.

Upon the high hills in this vicinity, as Mount Jolly, drift striæ are very finely shown, and in several sets. At Tyler Wilcox's house two sets were observed upon the same ledge, N. 20° E. and N. 20° W. At Halifax Center, it is thought there might be three sets of striæ, N. 60° W., in addition to the others. They are all found upon the edges of vertical stata of mica schist. The strike of mica schist in Halifax is S. 45° W.

Talcose schist is first found in the west side of the valley of the north branch of Deerfield River, about one and one-half miles west of Halifax Center. The strata are vertical, and the strike is N. 35° E. Upon the farm of Oliver Niles, plumbaginous and pyritiferous shales occur. The decomposition of the pyrites and shales has given rise to the formation of alum and copperas, but in small quantities. The dip of the shales is 65° S.E.

At Jacksonville, in the east part of Whitingham, commences the great gneiss formation of the Green Mountains, with strata running N. 30° E., and dipping 40° E. We have thus passed over another synclinal between West Guilford and Jacksonville, with a great thickness of perpendicular strata in the middle of its basin. It is hence not improbable that the mass of perpendicular strata may be the remnant of another axis, with its flanks so squeezed together that they stand vertically side by side. Some of the other sections favor this view.

The gneiss of the Green Mountains is generally obscure. In Massachusetts it was called mica schist because of the scarcity of feldspar in it. So here, and in many parts of the Green Mountains, the feldspar is in exceeding small proportion, and might appropriately be called feldspathic mica schist.

From Jacksonville to Whitingham the dip of the gneiss decreases, till it is horizontal for a short distance. The center of Whitingham is the middle of the anticlinal, for the rock here begins to dip west at a much steeper angle than upon the east of the fold. In the valley of a tributary of Deerfield River a bed of white crystalline limestone is found. It belongs to Jonathan Dix and Shubal Atherton. It is in the bed of the brook, and is three or four rods wide, with a dip of 40° W., and direction of N. 10° W. It contains crystals of foreign minerals, and, in company with some other beds in this vicinity, is the most thoroughly crystalline of any limestone in the State. The other beds of limestone are found west of Atherton's. One of them, belonging to J. Kentfield, is very pure carbonate of lime, containing only 2.50 per cent. of foreign matters. The direction of this bed is N. 10° W., and it dips 25° W. There are other beds of limestone in Readsboro, mostly of small size, yet often supplying large limekilns.

The valley directly west of Whitingham is a valley of erosion, and the amount removed might easily be calculated. But the valley of Deerfield River is a natural valley, where its course is about north and south in southern Vermont; for it is in a synclinal trough, as the protracted section shows. The dip is very small in this valley, sometimes as low as 5°. At Readsboro Hollow the west side of the synclinal is reached, the dip being 30° E. From Readsboro Hollow to Stamford Center the easterly dip is constant, but the amount of inclination variable. At Readsboro Falls it is 45° E., with a direction of N. 10° W. Northeast of Hartwellville, about three miles north of the line of the section, the dip is 80° E., which is probably the same dip as that south of Hartwellville on the line of the section. At Hartwellville the dip of the gneiss is 40° E.; but as it is near quartz rock it agrees better with the dip of the gneiss in the east part of Stamford Hollow.

Owing to the round-about nature of the road, we were unable to examine the dip of the rock precisely upon the proposed line of the section. Upon looking at the section one sees the possibility of the existence of an inverted anticlinal upon the highest ridge of the mountains.

In this general account of Section I, we must not forget to notice the Surface Geology. The most striking feature of it is the number and size of bowlders. Along Deerfield River they are immense, and the bed of the river seems to be filled with them. The largest one seen was upon the farm of Jonathan Dix, in West Whitingham, estimated to weigh 3400 tons. A sketch of this, and an account of the others, is given in another part of this Report.

At Hartwellville and in Stamford are beds of brown hematite, which are believed to belong to the newer, perhaps the pliocene, tertiary.

In Stamford, west of the village, are strata of quartz rock, dipping east at a small angle, and also of an obscure gneiss underlying the quartz. The latter is much contorted, and contains a peculiar blue hyaline quartz, found only in the granite of the Green Mountains, and in the form of pebbles in the great range of quartz rock. This dips about 30° S.E. Climbing the great hill west of Stamford, monstrous bowlders of granite appear, and presently the granite itself, which contains blue hyaline quartz. So peculiar is this granite that, insensibly, the distinctive name of *Stamford granite* has been used by us in our notes and conversations; and should that term, by inadvertence, appear in any part of our Report, its origin and meaning will be known.

This rock, which may be eruptive, extends between three and four miles, to the east part of Pownal. It is mostly covered by drift; especially its connection with the quartz rock west. But in Clarksburgh, Mass., three miles south, the junction of the two rocks may be seen, and we have supposed that the situation of the two in Pownal is similar. In Clarksburgh, the quartz rock dips east until within fifty rods of the granite, when the dip changes to 25° W., and 10° W. at the immediate junction. Whether this westerly dip is normal, or produced by the upheaval of the granite, is as yet uncertain. The granite is probably not a great belt, as it appears in Plate XV. All of the quartz rock seen in Pownal dips to the east about 20°. West of it, and underlying it is white crystalline limestone with essentially the same dip. The age of these rocks has been warmly discussed for many years. Prof. Emmons regards them as pre-Silurian. Others regard them as lower Silurian.

West of this crystalline or Eolian limestone, upon a short range of hills east of Pownal village is talco-argillaceous slate with a direction of N. 25° E., and easterly inclination of 25°—thus underlying the limestone.

The Eolian limestone is again seen in Pownal village (South Pownal and Pownal Center), with a small easterly dip. West of the limestone is found talco-micaceous or talcoid schist, continuing into New York. This probably dips east, underlying the limestones, slates and quartz rocks in the east part of Pownal.

In the valley of Hoosac River is an interesting deposit of consolidated drift, cemented probably by carbonate of lime. Also there may be seen high terraces, moraine terraces, old sea bottoms and tertiary deposits on or near the line of this section, in Pownal.

We present now a Catalogue of the specimens illustrating Section I. in the State Cabinet, and at the end of the description of each Section a similar catalogue. The catalogues of these sections possess a permanent value, because the specimens are enumerated both in a geographical and a geological order from east to west.

SPECIMENS ILLUSTRATING SECTION I. IN THE STATE CABINET.

GNEISS.

1 Mica schist, South Vernon depot.
2 Greenstone from a dike, South Vernon depot.
3 Altered gneiss, South Vernon depot.
4 Massive hornblende, South Vernon.
5 Schistose gneiss, South Vernon.
6 Hornblendic gneiss, Northfield, Mass.
7 Quartz and feldspar, State line.
8 Quartz and feldspar, State line.
9 Fine mica schist, South Vernon.
10 Mica schist, South Vernon.
11 Granitic gneiss, Vernon.
12 Dark colored gneiss, Vernon.
13 Epidotic gneiss, Vernon.
14 Gneiss, smoothed by sliding, Vernon.

QUARTZ ROCK.

15 Micaceous quartz, South Vernon.
16 Micaceous quartz, South Vernon.
17 Red decomposing quartz, S.W. Vernon.
18 Whitish quartz, S.W. Vernon.
19 Massive quartz rock, North Vernon.
20 Quartz rock, North Vernon.
21 Quartz rock, North Vernon.
22 Quartz rock, North Vernon.
23 Quartz rock, North Vernon.
24 White gritty quartz from a dike, North Vernon.
25 White gritty quartz from a dike, North Vernon.
26 Gneissoid rock, North Vernon.
27 Gneissoid rock, North Vernon.

CLAY SLATE.

28 Clay slate, S.W. Vernon.
29 Granite, South Guilford.
30 Silicious limestone, south of slate quarries, Guilford.
31 Clay slate, with pitted surface, Brattleboro and Guilford slate quarry, Guilford.
32 Clay slate with iron pyrites, Brattleboro and Guilford slate quarry, Guilford.
33 Jointed clay slate, Guilford.
34 Jointed clay slate, Guilford.
35 Clay slate, with waved surface, New England slate quarry, Guilford.
36 Clay slate with waved surface, New England slate quarry, Guilford.
37 Spotted clay slate, Guilford.
38 Bluish clay slate, Guilford.
39 Clay slate, contorted, Guilford.
40 Novaculite, Guilford.
41 Jointed Novaculite, Guilford. ($\frac{1}{16}$)
42 Clay slate with Andalusite, Guilford.
43 Argillo-mica slate, Guilford.

CALCIFEROUS MICA SCHIST.

44 Argillo-mica schist, Algiers.
45 Mica schist, Guilford.
46 Silicious limestone interstratified with No. 45, Guilford.
47 Green hornblende schist, Guilford.
48 Granite vein in silicious limestone, Guilford.
49 Mica schist with Garnets, West Guilford.
50 Compact mica schist, East Halifax.

TALCOSE SCHIST.

51 Talcose rock, West Halifax.
52 Talcose rock with Adamsite, West Halifax.
53 Talcose schist (arenaceous), West Halifax.
54 Plumbaginous slate, West Halifax.
55 Decomposing talcose schist, West Halifax.

GNEISS.

56 Feldspathic mica schist, Jacksonville.
57 Gneiss, Whitingham.
58 White gneiss, Whitingham.
59 Gneiss from the Green Mountain Giant bowlder, Whitingham.
60 White limestone (Dix's), Whitingham.
61 Micaceous limestone (Dix's), Whitingham.
62 Hyaline quartz from a vein in limestone, Whitingham.
63 White limestone, Kentfield's quarry, Whitingham.
64 Feldspathic mica schist, Readsboro.
65 Contorted mica schist, Readsboro.

PLIOCENE TERTIARY.

66 Quartz breccia cemented by Hematite, Hartwellville.
67 Quartz breccia, cemented by Hematite, Hartwellville.
68 Quartz breccia cemented by Hematite, Hartwellville.

MICA SCHIST.

69 Mica schist, colored red by iron, Hartwellville.
70 Feldspathic mica schist, Stamford.
71 Feldspathic mica schist, Stamford.
72 Felspathic mica schist, East Stamford.

QUARTZ ROCK.

73 Feldspar with blue quartz, Hartwellville.
74 Quartz rock, Hartwellville.
75 Quartz, slightly decomposing, Hartwellville.
76 Quartz with a little mica, Hartwellville.
77 Quartz passing into mica schist, Stamford.
78 Quartz rock (flagging stone), Stamford.

GRANITE.

79 Hornblendic gneiss (bowlder), Stamford.
80 Indistinct gneiss, Stamford.
81 Granite with blue quartz, Stamford.
82 Granite with blue quartz, Stamford.
83 Granite with blue quartz, Clarksburgh, Mass.

QUARTZ ROCK.

84 Coarse conglomerate, Clarksburgh, Mass.
85 Quartz rock, Pownal.

EOLIAN LIMESTONE.

86 Gray limestone, Pownal.

TALCOID SCHIST.

87 Talco-micaceous schist, Pownal.
88 Talco-argillaceous schist, Pownal.

EOLIAN LIMESTONE, Etc.

89 Friable white limestone, North Pownal.
90 Brownish limestone, North Pownal.
91 Striped limestone, North Pownal.
92 Gravel cemented by lime (alluvial), Pownal.
93 Coarse gravel cemented by lime (alluvial), Pownal.

TALCOID SCHIST.

94 Talco-argillaceous slate, Pownal.
95 Talco-argillaceous slate, Pownal.

APPENDIX TO SECTION I.

96 Gray limestone with calcite, 50 feet east of the excavation for the Hoosac Tunnel, (Aug. 1858), North Adams, Mass.
97 Drusy quartz above the Tunnel, North Adams, Mass.
98 Gray limestone 300 feet from the mouth of the Tunnel, North Adams, Mass.
99 Gray limestone from the Tunnel, North Adams, Mass.
100 Whitish limestone from the Tunnel, North Adams, Mass.
101 Talcose schist from the small Tunnel, North Adams, Mass.
102 Talcose schist, North Adams, Mass.
103 White Eolian limestone, north base of Greylock, North Adams, Mass.
104 Quartz rock reddened by fire, North Adams, Mass.
105 Jointed quartz rock, North Adams, Mass.
106 Granular quartz, North Adams, Mass.
107 Dendritic limestone, Hoosac Tunnel, North Adams, Mass.
108 Silicious limestone with trap, Bennington.

In the *Appendices* to the Catalogues of the specimens collected upon the various Sections, are found lists of specimens which have been collected at various times during the prosecution of the survey, between any two Sections. The specimens enumerated in the appendices were, in every case except a part of the appendix to Section I, collected north of the line of the Section.

SECTION II.

The second section commences on the east side of Connecticut River, opposite Brattleboro, in Chesterfield, N. H., and extends to the State line between Bennington, Vt., and Hoosac, N. Y., a distance of thirty-six miles. It passes through Brattleboro, Marlboro, Wilmington, Searsburgh, Woodford, and Bennington. Opposite Brattleboro is Mount Wantastoquit, in Chesterfield, N. H., 1050 feet above Connecticut River, at its base, rising very suddenly. It is mostly composed of clay slate, which, at the base of the mountain has a direction of N. 23° E., and dips 85° W. Associated with it are seams of mica schist, by means of which we determine the inclination. The clay slate, almost everywhere in New England, has a very high dip. In Vermont the prevailing dip is from 60° to 90°. Hence, many have regarded these divisional planes as cleavage planes. We would gladly receive this as the correct view, could we find any other marks of stratification that are tolerably constant, and also if it could be shown that cleavage can separate into successive layers the different kinds of sediment, distinguished as they are in Chesterfield and elsewhere by a difference in color, texture, mineral composition and structure. There are irregular planes in Chesterfield and Brattleboro which might be called planes of stratification, were it not for the objections which we have stated, and for their great irregularity. On the east side of the river these occasional planes dip 28° W., and at Brattleboro depot they dip 20° N.E.

Much of this clay slate is filled with little spherical masses resembling concretions (No. $\frac{2}{1}$ in Cabinet); and other specimens present a waved surface. At Brattleboro depot the strike is N. E. and S. W., and the dip 66° E.; thus forming a synclinal axis in which Connecticut River flows. With the clay slate there are associated frequent seams or strata of talcose schist and talcy quartz (Nos. $\frac{2}{5}$, $\frac{2}{6}$). Some variations in the dip of the clay slate exist in the west part of the village: and though the dip is sometimes 60°W., it is doubtful whether it is more than a local variation. This formation runs several degrees east of north, and therefore its western limit is reached sooner than upon Section I. The calciferous mica schist appears at an axe factory, in the west part of the village, running N. 28° E., and is inclined 50° E.

Surface geology is finely represented in Brattleboro. The former marks of aqueous agency upon Mount Wantastoquit, the planished ledges of clay slate in Brattleboro village, particularly near the mouth of West River, and the complicated and numerous terraces, both in East and West Brattleboro, afford pleasure to those not acquainted with theoretical geology; and those who wish to learn their scientific relations will find them discussed in Part I. of this Report.

The same anticlinal that was found imperfectly represented in Guilford, is seen in perfection in West Brattleboro and Marlboro. West of the former village is green hornblende schist running N. 28° E., and dipping 67° E., containing occasional blotches of feldspar. This is succeeded on the west by a gneissoid rock containing numerous small garnets and some crystals of hornblende, associated with quartzose strata; all dipping beneath the hornblende schist finally at an angle of 15°. Just west of a guideboard which says, "To Marlboro 6 miles" occurs the gneissoid rock with a dip of 18°W. This in turn is succeeded by green hornblende schist, dipping 38°W. and 45°W., and at length, by calciferous mica schist, running northeast and southwest, dipping 70° N. and 80°W. Thus the different rocks succeed each other in inverse order upon their anticlinal axis, and a hasty sketch in Fig. 110 will show how much solid rock has been removed by erosion.

West of this anticlinal the limestone disappears, and gneiss and hornblende schist take the place of mica schist. The dip also is changed, it being 73° E. in the extreme east part of Marlboro, with the direction of N. 8° E. The hornblende schist becomes porphyritic, and a width of it of towards half a mile is represented upon the section. Strata and tubercular masses of quartz, with decomposing strata of mica schist, are associated with gneiss, east of Marlboro village. West of the village is hornblende schist with feldspar dipping 80°E.; hornblendic gneiss, dipping 75° E. and 55° E., with a direction of N. 20° E. Radiating crystals of hornblende (fasciculite), occur in the village and west of it, towards Union house, where beds of beautiful hornblende schist are interstratified with gneiss, dipping 55° E. and running N. 34° E.

This assemblage of gneiss and hornblende rocks lying west of the Brattleboro anticlinal we regard as belonging to a gneiss formation equivalent to the gneiss of the Green Mountains, although it is separated from it by the talcose schist. As it is represented upon the map, it runs out between the first and second Sections, and continues to widen on the north as far as Section V, and before reaching Section VII. it has disappeared. Upon comparing the first two Sections we are almost inclined to believe that what was ranked as mica schist upon the first Section, near Halifax Center, is the same as the Marlboro gneiss. It would have been easy to mistake an obscure gneiss for mica schist; and it is certain that there was no limestone associated with it west of Mount Jolly. An inquiry of some importance would be whether the gneiss might not be altered mica schist, and therefore newer than the Green Mountain gneiss.

Upon the top of the hill east of the Methodist church, in the west part of Marlboro, is a schist verging into a talcose character, associated with soft, whetstone schist. Although a small amount of gneiss occurs here, we consider these rocks as forming the eastern limit of the talcose schist formation, dipping 30° E. Upon the summit of the hill there is green hornblende schist, somewhat contorted, dipping 25° E. In the valley there seems to be the middle of another anticlinal — the talcose schist west of the Methodist church dipping 18° N. with a strike of N. 70° E. With this are associated green massive hornblende rock, containing beautiful garnets, and gneissoid and quartzose strata. North of this spot is Hosea Ballou's bed of steatite. It runs about N. 20° E., with an easterly dip of 40°–50°. The stone is of excellent quality, free from brown spar, fifty feet wide at the southern end and well situated for drainage. A bed of steatite half a mile north, upon Ward Belus' farm, and another two or three miles north, upon Clark Worden's farm, belong to the same belt of rocks.

The strata west of the steatite are very much twisted and disarranged. Until the top of the hill is reached, they are mostly thin-bedded black hornblende schist, dipping some 30° E., with others varying from this to 70° W. A strike was recorded near by with direction N. 32° E. Another measurement of this rock showed the direction of E. and W., and a dip 14°–24° N. The general dip of the whole, subtracting the irregularities, was thought to be about 15° E., which is the precise dip of the rock on top of the hill.

A mile more of traveling showed us all the talcose schist remaining, having the direction N. 45° E., and a variable dip of 90°, 70° W., and 90°. Hence, there is an anticlinal between the Methodist Church and the western limit of the talcose rocks.

The first ledge of the gneiss formation next west, was seen at a saw mill in the east part of Wilmington. It is of a greenish color, and is distinguished from talcose schist mostly by the presence of crystals of feldspar. Its direction is N. 30° E., and the dip 55° W. With it is a little green hornblende schist. Adjacent ledges of gneiss confirmed us in the view taken of its character.

About one mile east of Wilmington Center the gneiss is very distinct, with strike N. 75° W., dipping 20° northerly. Particularly upon a conical hill of fifty feet altitude, gneiss and hornblende schist are associated, whose lithological character is unusually distinctive, dipping 7° northwesterly. Wilmington is in the trough of a synclinal, and the rocks upon the west side of this basin, a mile south of Wilmington, upon Deerfield River, dip 5° S.E., and subsequently 20° E., and 20° S.E.

The gneiss rock in the east part of Searsburgh is very peculiar in its character. It is a very coarse green massive rock, often filled with large garnets, and frequently made up of great blotches of an argillaceous schist, with much quartz and feldspar in veins. At a distance it resembles talcose schist. Perhaps the huge bowlders covering the sides of the valley (Deerfield River), and the rough, precipitous nature of the country, may have added to our conceptions of the uncouth nature of the rock. The scenery about Robinson's Hotel particularly attracted our attention. The house is situated in a bend in the river, which, with glacial agencies, has scooped out a basin 1500 feet deep in the solid rock, with very precipitous sides. On the north the hills are too steep to allow vegetation a foothold; but the hills on the south are less steep, and they were, where covered with trees at the time of our visit, richly painted with the gaudy colors of the autumn. Above the forest might be seen, upon the bald summit, cities of bowlders, almost in rows. Great bowlders and glacial striæ in the valley, showed us that a former glacier had been shaping this valley into its present romantic form.

The last ledge of this rock we noticed was half a mile northwest of Robinson's Hotel, whose dip is 37° E. It is filled with branching veins of orthoclase (feldspar), and the layers are much twisted. Large nodules, like pebbles, occasionally appeared. We would liken the appearance of the rock, with its varying colors of green or bluish-green and white, to a coarse kind of cotton cloth, twilled, with large stripes of blue and white.

West of Deerfield River, on the Bennington road, and about one-fourth of a mile west of the striped gneiss, is a ledge of gneissoid rock, resembling quartz, with the direction N. 60° E., and the dip 75° S.E. The layers were as true as the laminæ of roofing slate, and we should have considered them as chemical planes were they not of different colors, and decomposing with different degrees of rapidity—some decomposing white and others red. A bowlder of this rock contained obscure crystals of galena.

In passing up the valley of Deerfield River in Searsburgh, not on the route of Section II, but crossing rocks which are west of any hitherto observed upon this section, the first ledge we find runs N. 50° E., and dips 50° S.E. At a great bend in the river the ledges are very abundant, and the strata are nearly vertical. The rock consists largely of silica. Near the north line of Somerset the gneiss becomes hornblendic, almost porphyritic, and is still vertical. On the Somerset line the gneiss runs N. 30° E., and dips from 30° to 40° W. In "Texas" the strike is the same, and the dip 75° E. Still further to the northwest the dip continues easterly. We have transferred these inclinations to the colored section, because on the route of the section between Deerfield River and the west part of Woodford, near the toll-gate, no rock was seen in place. Numerous bowlders of gneiss, many of quartz rock, and a few of the Stamford granite covered the surface. The presumption is that gneiss is the rock in place associated perhaps with granite in the western part. At Woodford Pond, on the north side, a small pond rampart, estimated at twelve rods in length, was noticed.

The road from Woodford to Bennington is through a deep valley filled with quartz "hardheads," which were probably thrown in there during the drift period. Tertiary deposits of hematite and kaolin clays are found beneath them in the lower part of the valley, as far as Bennington. In East Bennington particularly the tertiary is well developed; large quantities of hematite having been mined in years past, and ochre and clay being dug constantly at present for economical purposes. Some of the kaolin beds contained stems of plants, which may possibly be allied to the fruits of Brandon of the same age.

Near the toll-gate in Woodford, vertical strata of quartz rock, like those in Searsburgh, appear. Further west, upon the town line, is a ledge of beautiful stratified quartz rock, nearly horizontal, dipping slightly to the east we believe, and resembling Potsdam sandstone. The high hills east of Bennington, as Bald Mountain, 3124 feet above the ocean, are composed of this same quartz rock dipping eastwardly.

North of Bennington, at Gen. Harwood's quarry, is a fine locality of the *Scolithus linearis* (Hall.) Prof. Hall found this fossil in a loose block at North Adams, Mass., and described it in his Palæontology, Vol. I, as a characteristic fossil of the Potsdam sandstone.

West of East Bennington is white and gray crystalline limestone of the Eolian series. Its connection with the quartz has nowhere been observed in the State. The course of the first observed ledge of Eolian limestone, only fifty rods west of Bennington post-office, is N. 43° W., and the dip is 15° S.W. It is fetid and associated with strata of quartz rock of small thickness. The precise character of every layer between East Bennington and the schists of Mount Anthony will be found in another part of the Report. We will only say here that the southwesterly dip of the limestone is constant beneath the schists, that obscure encrinites and small Orthocerata seemed to us to occur in the limestones, though no specimens could be procured on account of the friable nature of the decomposing rock, and that a layer of marble capped the limestone. At 728 feet above East Bennington, black shales are found dipping 12° S.E., overlying the limestone, and therefore it must be newer than the limestone. We would say, once for all, that the great band of white limestone found west of the quartz rock upon the first eight sections is of the same age, and is probably of Silurian age. The reasons for this view are given in full in another place. About 1800 feet of the upper portion of Mount Anthony are composed of shales and schists newer than the Eolian limestone.

By following around the base of Mount Anthony, limestone may be traced the whole distance, nearly to the State line. At Hubbell's marble quarry there are from 15–20 feet of bluish and reddish streaked marble, and in the midst of it is seven feet of black unaltered limestone, greatly resembling the Trenton limestone upon Lake Champlain, bating the fossils. Yet we doubt not that a careful search would discover fossils. We spent only ten minutes at dusk at the locality, and did not satisfy ourselves of the presence or absence of fossils. At the same place is an abundance of flesh-colored calcite in a vein. The strata dip 15° W., and run N. 12° W.

Whipstock Hill is made of black shales, considerably contorted, with a direction of N. 33° E., and dip of 30° E. Hence it probably runs under the limestone, unless there is a fault between them.

An immense amount of strata has been denuded from Bennington in early geological periods. For if we protract strata that protrude from the sides of the mountains until they meet each other, we shall find that over a thousand feet of shales, with several hundred feet of limestone, have been removed from an area of more than six miles square in Bennington and Shaftsbury alone. The Taconic range is cut through between Mount Anthony and the great mountains in West Shaftsbury. The valley between is now covered by drift, and occasionally by limited deposits of tertiary age. The general geological aspect of the country west of the Green Mountains is quite different from that east of the mountains — the one being highly metamorphic and silicious, the other showing rocks unaltered or with the metamorphic process commenced, and in general highly calcareous.

SPECIMENS ILLUSTRATING SECTION II.

CLAY SLATE.

1 Clay slate with concretions (?), Chesterfield, N. H.
2 Crumpled clay slate, Chesterfield, N. H.
3 Mica schist (stratum), Chesterfield, N. H.
4 Clay slate, Brattleboro depot.
5 Talcose schist (stratum), Brattleboro depot.
6 Talcky quartz (stratum), Brattleboro depot.

CALCIFEROUS MICA SCHIST.

7 Contorted mica schist, Brattleboro.
8 Silicious limestone, Brattleboro.
9 Decomposing whetstone schist, Brattleboro.
10 Mica schist, Brattleboro.
11 Green hornblende schist with quartz, West Brattleboro.
12 Gneiss with small garnets, West Brattleboro.
13 Gneissoid rock with small garnets, West Brattleboro.
14 Mica schist, Brattleboro.
15 Mica schist, West Brattleboro.
16 Green hornblende schist corresponding to $\frac{2}{11}$ on the east side of the anticlinal axis, West Brattleboro.
17 Mica schist, West Brattleboro.
18 Mica schist, West Brattleboro.
19 Hornblende mica and quartz, Marlboro.
20 Decomposed limestone, Marlboro.
21 Hornblende schist, Marlboro.

GNEISS.

22 Quartz (stratum), Marlboro.
23 Hornblende schist, in numerous beds interstratified with gneiss, Marlboro.
24 Gneiss, Marlboro Center.
25 Hornblendic gneiss, Marlboro.
26 Hornblendic gneiss, Marlboro.
27 Hornblende schist, Marlboro.
28 Gneiss, Union house, Marlboro.
29 White quartz (vein), Marlboro.
30 White gneiss, Marlboro.
31 Green hornblende schist (in beds), Marlboro.
32 Hyaline quartz (stratum), Marlboro.
33 Gneiss, Marlboro.

TALCOSE SCHIST.

34 Talcose schist, Marlboro.
35 Talcose schist, Marlboro.
36 Quartz (stratum), Marlboro.
37 Hornblende schist, Methodist church.
38 Steatite, Clark Worden's, Marlboro.
39 Greenish steatite, Clark Worden's, Marlboro.
40 Chlorite, Clark Worden's, Marlboro.
41 Steatite, Ward Belus', Marlboro.
42 Hornblende rock, Ward Belus', Marlboro.
43 Steatite, Hosea Ballou's, Marlboro.
44 Steatite, Hosea Ballou's, Marlboro.
45 Talcose schist, Hosea Ballou's, Marlboro.
46 Talcose schist, near Methodist church, Marlboro.
47 Garnets in green hornblende schist, Marlboro.

GNEISS.

48 Hornblendic gneiss, Marlboro.
49 Gneiss, East Wilmington.
50 Gneiss, East Wilmington.
51 Gneiss, East Wilmington.
52 Hornblende schist, East Wilmington.
53 Gneiss, Wilmington.
54 Hornblende schist, Wilmington.
55 Porphyritic hornblende, Wilmington Center.
56 Mica schist, Wilmington.
57 Gneiss, West Wilmington.
58 Mica schist (bowlder), West Wilmington.
59 Garnets in mica schist, West Wilmington.
60 Mica schist, West Wilmington.
61 Mica schist, Robinson's Hotel, Searsburgh.
62 Granular quartz (stratum), Searsburgh.
63 Orthoclase (vein), Searsburgh.
64 Contorted mica schist, Searsburgh.
65 Quartz with pebbles of blue quartz, Searsburgh.
66 Quartz with pebbles of blue quartz, Searsburgh.
67 Quartz, tarnished (loose block), Searsburgh.
68 Galena in quartz (loose block), Searsburgh.
69 Gneiss, probably *in situ*, Woodford.
70 Gneiss, probably *in situ*, Woodford.
71 Gneiss, near toll-gate, West Woodford.
72 Gneiss, near toll-gate, West Woodford.
73 Gneiss, South Woodford.

QUARTZ ROCK.

74 Quartz, with slickensides, produced by a vein of specular iron, South Woodford.
75 Seams of talcose schist, South Woodford.
76 Variegated sandstone, South Woodford.

77 Greenish sandstone, passing into talcose slate, South Woodford.
78 Compact quartz sandstone, South Woodford.
79 Compact quartz sandstone, South Woodford.
80 Conglomerate of blue quartz (bowlder), South Woodford.
81 Compact quartz, east line of Bennington.
82 Tertiary kaolin, East Bennington.
83 Tertiary kaolin, East Bennington.
84 Decomposing quartz rock, with *Scolithus linearis* (Hall), Bennington.
85 *Scolithus linearis* (Hall), in quartz, Gen. Harwood's property, Bennington.

EOLIAN LIMESTONES.

86 Calciferous sandstone, Bennington.
87 Calciferous sandstone, Bennington.
88 Compact limestone, Bennington.
89 Compact limestone, Bennington.
90 Quartz rock (stratum), Bennington.
91 Fetid limestone, with chert and calcite, Bennington.
92 Grayish limestone, Mount Anthony.
93 Gray silicious limestone, Mount Anthony.
94 Limestone (marble), Mount Anthony.
95 Blue compact limestone, Mount Anthony.
96 Fetid quartz from No. 94, Mount Anthony.
97 Bluish marble, Hubbell's quarry, Mt. Anthony.
98 Reddish marble, Hubbell's quarry, Mt. Anthony.
99 Calcite, Hubbell's quarry, Mount Anthony.
100 Dark compact limestone, Hubbell's, Mt. Anthony.
101 Blue compact limestone, West Bennington.

TALCOID SCHIST GROUP.

102 Clay slate, Mount Anthony.
103 Contorted clay slate, Mount Anthony.
104 Clay slate, West Bennington.
105 Hematite, tertiary, West Bennington.
106 Calcite and fragments of slate, W. Bennington.
107 Limestone (bed in slate), West Bennington.
108 Quartz, with geodic cavities, W. Bennington.

APPENDIX TO SECTION II.

109 Silicious limestone, Harwood's quarry, Bennington.
110 Calciferous sandstone, Harwood's quarry, Bennington.
111 Silicious limestone, North Bennington.
112 Dark gray limestone, east of North Bennington.
113 Yellow ochre, East Bennington.
114 Breccia, South Shaftsbury.

TALCOID SCHIST, Etc.

115 Clay slate, Hoosac Falls, N. Y.
116 Clay slate, Waloomsac, N. Y.
117 Contorted clay slate, Waloomsac, N. Y.
118 Porous quartz, Waloomsac, N. Y.
119 Rippled clay slate, Hoosac, N. Y.
120 Irregular clay slate, Hoosac, N. Y.
121 Dark silicious limestone, Shaftsbury.
122 Gray limestone, Shaftsbury.
123 Dark colored limestone, Shaftsbury.
124 Sparry limestone, Shaftsbury.

EOLIAN LIMESTONES, Etc.

125 Gray limestone, above a thick mass of clay slate, North Shaftsbury.
126 Clay slate, North Shaftsbury.
127 Plumbaginous shales, North Shaftsbury.
128 Bluish limestone, underlying Nos. 126, 127.
129 Marble, Cranston's quarry, Shaftsbury.
130 Marble, Cranston's quarry, Shaftsbury.
131 White marble, Cranston's quarry, Shaftsbury.
132 Flesh-colored limestone, near the quartz rock, North Shaftsbury.
133 Calcareous quartz (upper bed of the Potsdam sandstone (?), one mile east of Shaftsbury depot.
134 Milk quartz, from Potsdam sandstone (?) seam), South Shaftsbury.
135 Decomposing quartz rock, South Shaftsbury.
136 Decomposing quartz rock, South Shaftsbury.
137 Kaolin clay, East Bennington.
138 Breccia, South Shaftsbury.

SECTION III.

The third Section extends from Connecticut River at Dummerston, passing through Newfane, Wardsboro, Stratton, Sunderland and Arlington, to Shushan, N. Y., a distance of forty-three miles. It is represented on Plate XV. As in Section II, the first rock at the east end (for we commence the description of each Section, as well as the catalogue, at the east end), is clay slate. The course of this rock near Dummerston depot is N. 47° E., and the dip varies from 35° E. to 50° E. In the vicinity the slate is very much broken and contorted, perhaps by drift agency, so that inclinations to every point of the compass might be found over limited areas. Near Dummerston the dip varies from 45° E. to 75° E. At Dummerston Center is the boundary between the clay slate and the calciferous mica schist, the dip of both being 51° E., and their direction N. 20° E. This is the common direction and dip for all the strata between Dummerston and Black Mountain.

Black Mountain is composed of eruptive granite. It is a fine-grained, compact rock, valuable as a building stone, and bowlders of it may be found over the whole Connecticut valley in Massachusetts, both in the drift and Connecticut River sandstone formations. The top of the mountain is flat, and the ledges are beautifully embossed, but the striæ have been obliterated. The granite, as will be seen on the map, extends northward to a point—and the adjacent strata seem to have been disturbed by the upheaval of the granite, the strike of the schists north of the granite being N. 70° E. This granite is in the middle of an anticlinal axis, corresponding to those anticlinals upon the first and second Sections which had gneiss in the middle. It is not unlikely that this granite was produced by the melting of the subjacent gneiss. Similar masses of granite are found near Connecticut River, the whole length of the State, and they extend also into Canada, where they have been shown satisfactorily to have been erupted in the Devonian period.

This granite occurs in large plates—at times resembling strata, and conformable to them—on the west side. On the west flank of the mountain, near West River, mica schist is found above the granite, with a dip of 50° northwesterly, corresponding with the direction N. 70° E. The inclination becomes steeper as we proceed westward, till at the union of the two principal branches of West River, on the west line of Dummerston, it is as high as 80° W., with the direction of N. 30° E. Here there is a great amount of limestone associated with plumbaginous shales. A fine view of these strata is afforded upon the river road to Williamsville, because the stream has denuded the loose alluvium almost entirely.

At Williamsville the schists dip 65° E., and run N. 30° E., thus constituting the west side of a synclinal axis. The same disposition of strata is seen at Fayetteville, the two villages being built upon the same geological horizon. At Fayetteville the mica schists dip 50° E., while the hornblende schists west are inclined only 10° E., and there is inclosed within them a vein of beautiful concretionary granite ten feet wide. The hornblende schists at Williamsville are more compact and massive, and contain numerous crystals of feldspar, giving it a porphyritic aspect. The latter rock is about a mile in width, and contains in nodular masses fine crystals of rutile and ilmenite. This hornblende schist probably belongs to the gneiss formation upon which we are about to enter, because both at Williamsville and Fayetteville, from whence a short section has been drawn to North Wardsboro (see Plate

XV.), it overlies the gneiss, and corresponds with similar bands overlying the gneiss upon its western border.

These sections show that there is an anticlinal axis in this belt of gneiss. At Williamsville the rock dips 30° E., and runs N. 30° E. To the west it has the direction N.W. and S.E. On the west side of the fold, it dips 50° with the strike N. 60° E., and a short distance further it dips 40° and runs N. 45° E. The overlying hornblende schists dip 60°W.

Underlying the hornblende schists at Fayetteville the gneiss dips 15° E., and continues at this angle until it suddenly dips at an angle of 70° W., with the direction N. 40° E. Still further west, where the feldspar predominates in large blotches, the dip is 65° W. Thus in this fold we see very plainly the normal character of the folds in the Apalachian ranges: namely, a much steeper inclination upon the west than upon the east sides. Instances of this character will be seen upon almost every one of the general sections. It would be very easy to imagine such a modification of force as should push the east side of the fold so strongly against the west side that both sides would dip to the east and form an inverted anticlinal. It is this feature that we referred to upon the first and second sections, when we suggested the existence of an anticlinal at Halifax and Marlboro. Upon comparing the three sections with the local section now under discussion, it will be seen that upon each southern section the dip grows greater, becoming vertical at Halifax. If now we can imagine the plicating force to have been greater and greater, as we proceed south, it will be easy to suppose that the anticlinal exists upon the southern sections, but in an inverted position. The fourth and fifth sections make this theory still more probable.

We next arrive at the talcose schist formation. The two sections now before us show that there are two synclinal and one anticlinal axes within it, which is unusual, there being less variation in the dip upon most of the veins of this formation. At the western edge of Newfane there is a large bed of steatite and serpentine with the average direction of N. 15° E., and average dip of 75° W., which is being worked by the Vermont Soapstone Company. Between this bed and South Wardsboro, the strike of the ledges is N. 40° E., with an easterly dip, thus constituting a synclinal axis. At South Wardsboro the dip is 25° W., and here is an anticlinal. Between South Wardsboro and West Wardsboro we pass over another synclinal; the dip near the south village being 40° E. Large veins of milk-white quartz are abundant upon this synclinal.

West of the hornblendic gneiss upon the north section, the talcose schist dips 75° W., and at another place the dip is 58° W., with the direction N. 5° E. Upon casting the eye over the country in this elevated region, one sees an extensive plain, with a high range of mountains upon the southwest border. At the western edge of this so-called plain, upon Eliab Scott's farm, are several pot-holes, 1560 feet above the ocean. The strata in the vicinity are green hornblende and talcose shales dipping 20° E. Passing down a very crooked valley to North Wardsboro, at a saw mill, the talcose schist dips 25° southerly, and with it are associated many beds of hyaline quartz (No. $\frac{5}{28}$), probably at the same horizon with the milky quartz near South Wardsboro. Talco-micaceous schist is seen next with the dip of 45° south-westerly, and the direction N. 65° W. Rather more than a mile from the village are talcose schists of the soft green shaly and tough varieties (Nos. $\frac{3}{29}$, $\frac{3}{30}$, $\frac{3}{31}$), and green hornblende schist (No. $\frac{3}{32}$), dipping 21° W. One mile east of North Wardsboro the strata are horizontal.

The western limit of the talcose schist is not far from John E. Kidder's house, North Wardsboro, where gneiss appears, dipping 25° E. In the bed of a branch of West River near the village, the gneiss assumes a dark appearance, owing to the predominance of black mica in it, and it dips 27° E. with the direction N. 40° E. The dip of jointed seams in the ledges is 85° W., and their direction N. 55° W.

Near West Wardsboro upon a small rounded hill, the feldspathic mica schist runs N. 70° E., and dips 35° southeasterly. Upon the hill west of West Wardsboro village, the rock appears talcose (No. $\frac{3}{43}$), but is hornblende schist, with the strike N. 40° E., and dip 45° S.E. Three sets of drift striæ were observed running up this hill at various angles from 12° to 25°. Patches of the peculiar gneiss seen in Searsburgh occasionally occur in this vicinity, particularly at the famous pot-hole 2235 feet above the ocean, on the old town line between Wardsboro and Somerset, the dip being 35° E.

In the northeast corner of what was Somerset at the time of our visit in 1857, but is now in Stratton by Legislative authority, there are two beds of dolomite, belonging to Rufus Lyman, where lime is manufactured. The inclosing gneiss (mica schist), runs N. 30° E., and dips 45° E. The largest bed is 66 feet wide, in which there are several varieties of limestone of several colors and difference in compactness, with small veins of quartz, and the smaller bed is ten feet wide. The two beds are as much as ten rods apart, the smaller one in the bed of a brook, and the other upon the west side of the brook, thirty or forty feet above it. The rock has been analyzed and its composition shows it to be a true dolomite.

Bowlders of a very peculiar coarse granite are very abundant in the west part of Wardsboro ($\frac{3}{45}$), and in Stratton. When upon the Pot-hole Mountain, our attention was arrested by some white rocks, shining by the reflection of the sun, north of Stratton village. An intelligent gentleman with us said that large plates of mica were found there, and it is northwest from the bowlders, we think, that granite occurs *in situ* there, and we have accordingly represented it upon the Map. Its character is much like that at Stamford.

There is very little of interest in the gneiss formation west of Wardsboro, inasmuch as it is almost entirely covered by drift accumulations. In the east part of Stratton small pebbles of blue hyaline quartz were abundant. At a saw mill near the top of the *road(?)* over Stratton Mountain the gneiss is very distinct, and runs N. 10° E., dipping 55° E. The next ledge seen is west of Kelly's Hotel in Sunderland, which is distinct gneiss with the direction N. 70° E., the strata standing upon their edges. To the west in following down the mountain the rocks appear more like mica schist than gneiss, though feldspar is present. We found them with the direction N. 70° E., and the dip 56° southerly. Near the western border of the formation is distinct gneiss, running N. 45° E., and dipping 60° southeast. At the junction of the gneiss with quartz rock in the west part of Sunderland the position of the gneiss is quite variable, owing to the disturbing effect of a large quantity of the "Stamford granite." An enlarged Section drawn to illustrate this connection, will be found under QUARTZ ROCK.

An inspection of the gneiss upon Section III, shows a great variation in the dip, but brings to light no westerly dip — yet we may feel assured of the presence of at least one axis, either anticlinal or synclinal, and the presence of more than one would rather be looked for on account of the great thickness of the strata.

The quartz formation in Sunderland is well represented by specimens in the State Cabinet (Nos. $\frac{3}{60}$ to $\frac{3}{74}$.) These varieties occur: Talcose schist, unmixed, and also containing crystals of iron pyrites, a conglomerate containing many blue quartz pebbles, brown sandstone, white vitrified quartz, reddish brown sandstone and the ordinary grayish granular quartz of the formation. In structure the formation appears as a synclinal axis, the east end dipping 20° W., resting upon a heterogeneous mixture of granite and gneiss, the west end dipping 20° S. E. Prof. Emmons has given a Section of this basin, and regards the quartz as the granular quartz of the Taconic system, resting unconformably upon the [Laurentian] crystalline rocks, and if we understand his section, it rests upon it distinctly with no special evidence of disturbance.

At a saw-mill near the eastern limit of this formation, a geologist will notice a remarkable profusion of the *Scolithus linearis*. Upon a cliff six feet high this fossil may be seen running through the strata for several feet nearly at right angles to them, and covering probably several square rods of surface. Such a profusion of it almost staggers one in the belief of its organic character. Those who wish to examine this locality will find it easily accessible, it being only three miles from Arlington station on the Western Vermont Railroad.

At East Arlington there may be found deposits of glass sand, etc., referable to the tertiary period.

The first ledge of Eolian limestone in Arlington runs N. 13° E. and dips 45° E. The dip decreases to the west, being 23° E. near Arlington church and about horizontal at Battenkill River. On the west side of the river there are several quarries of marble, O. & A. D. Canfield's, West, Canfield & Co., McKee's, etc., all of which dip westwardly and run under the great mountain of talcoid schist. Thus there is an anticlinal in the limestone and its whole thickness is supposed to run under the schists.

In O. & A. D. Canfield's south quarry there has been a slide, whence a large mass of limestone that has been dislocated dips 38° E. The marble at the north quarry dips 1°–5° east, but the same strata at the marble mills dip 4° W. There is a curious laminæ-like appearance in some of the strata. There are *streaks of color* in the thick stratum dipping 25° N.W., while the stratum is nearly horizontal. We were not satisfied that this was the result of lamination, but could assign no other adequate cause for their production.

Another curious fact about this marble is that much of it is composed of fragments of marble cemented together by carbonate of lime — properly a breccia. Some large specimens in the Cabinet show this feature perfectly. It is remarkable that the cemented fragments should constitute as good marble as the original rock. The specimens seem to prove that the strata were broken into fragments by some convulsion and were subsequently cemented by the infiltration of water among the fragments, which dissolved carbonate of lime from the upper fragments, and deposited it by degrees until all the spaces were filled, and the whole mass was then cemented together.

The limestone occupies the bottom of the valley of Battenkill River, as far as West Arlington. The last ledge of the limestone we saw, dipped 30° E. But only two rods east of this ledge, the strata dipped 5° W. It will assist in understanding the disposition of the rocks in Arlington, to recollect that west of Arlington Center, the river has cut a narrow passage for itself for six miles, across a range of mountains, 2,000–3,000 feet

above its bed, and that the strata upon this range are nearly horizontal; the upper and great portion being schists of various kinds, and the lower portion, say 300 feet, made of limestone and marble. The strata of schists are in the form of a synclinal axis, with its western side much lower than the eastern, so that the limestone beneath passes below the surface of the country, and does not appear again unless it be somewhere in New York. We have not examined these schists and slates upon Red Mountain and Bald Mountain, but suppose them identical with other strata examined further north, and perhaps with those on this section yet to be described.

The schists at the junction with the limestone are described in our notes as nearly horizontal, overlying the limestones. Soon it dips 25° E. Before reaching the State line, we pass over ordinary talcoid schists, brownish-green schists, green and slate-colored clay slates. At the State line the slates dip 15° W. Just over the line they are very irregular and variable, the dips 60° E. and 60° W. being contiguous in some instances. In Salem, N. Y., we passed different varieties of what the N. Y. Geological Report has called Hudson River group, at dips of 20° E., 50° E. and 30° E.

At Shoreham, the western limit of our explorations, the average strike was N. 30° E. and the ordinary dip 30° E. We did not notice any striking differences between the Hudson River shales in Salem, N. Y. and the clay slates of western Rutland Co., Vt., except that those in Vermont are more regular and of greater thickness.

Upon the Battenkill River there are many fine terraces, especially in Salem. In West Arlington there is one 350 feet high, a thickness exceeded only by one other example in the State.

In Arlington Center there are morain terraces and an old sea beach extending south to Shaftsbury. The deep valley of the Battenkill is a valley of erosion.

SPECIMENS ILLUSTRATING SECTION III.

CLAY SLATE.

1 Clay slate, Dummerston depot.
2 Clay schist, Dummerston.
3 Clay slate, Dummerston Center.

CALCIFEROUS MICA SCHIST.

4 Granite, Black Mountain, Dummerston.
5 Mica schist, west of the granite, Dummerston.
6 Hornblende in mica schist, Newfane (east line).
7 Silicious limestone, Newfane (east line.)
8 Mica schist, Newfane.
9 Quartz (vein), Newfane.
10 Hornblende schist, Williamsville.

GNEISS.

11 Gneiss, Williamsville.
12 Green hornblende schist, Newfane.
13 Gneiss, two miles north-west of Williamsville.
14 Green hornblende schist, Fayetteville.
15 Concretionary granite, Fayetteville.
16 Gneiss, near Fayetteville.

TALCOSE SCHIST.

17 Talcose schist, west of Fayetteville.
18 Green hornblende schist, one mile east of the soapstone quarry, Newfane.
19 Talcose schist with hornblende, Newfane.
20 Green hornblende schist, Newfane.
21 Chlorite schist, Newfane.

22 Serpentine, West Newfane.
23 Green soapstone, West Newfane.
24 Common soapstone, West Newfane.
25 Adamsite schist associated with Nos. 20 to 24.
26 Serpentine, on line between Newfane and Dover.
27 Green talcose schist, East Wardsboro.
28 Quartzose gneiss (stratum.)
29 Garnetiferous mica schist, Wardsboro.
30 Green hornblende schist, Wardsboro.
31 Epidotic hornblendic gneiss, Wardsboro.
32 Green hornblende schist, near North Wardsboro.
33 Talcose schist, North Wardsboro.
34 Green talcose schist, near South Wardsboro.

GNEISS.

35 Feldspathic mica schist, near North Wardsboro.
36 Feldspathic mica schist, near North Wardsboro.
37 Feldspathic mica schist, Wardsboro.
38 Granite (bowlder), West Wardsboro.
39 Granite with red feldspar (bowlder), West Wardsboro.
40 Coarse gneiss (bowlder), West Wardsboro.
41 Greenish gneiss, Pot-hole locality, West Wardsboro.
42 Gneiss, West Wardsboro.
43 Green hornblende schist, West Wardsboro.
44 Mica schist, West Wardsboro.
45 Coarse granite (bowlder), Stratton.
46 Feldspathic mica schist with pebbles of blue quartz, Stratton.
47 Mica schist, Stratton.
48 Micaceous limestone, Stratton.
49 Dolomite, Stratton.
50 Hyaline quartz from No. 49.
51 Gneiss, West Stratton.
52 Gneiss, Kelly's Hotel, Sunderland.
53 Gneiss (loose block), Sunderland.
54 Fine-grained gneiss (loose block), Sunderland.
55 Gneiss (western limit), Sunderland.
56 Granite with blue quartz, Sunderland.
57 Gneiss at the junction of gneiss and quartz rock, Sunderland.
58 Black gneiss (contorted) at the junction of gneiss and quartz rock, Sunderland.
59 Mica schist at junction of gneiss and quartz rock, Sunderland.

QUARTZ ROCK.

60 Granular quartz, Sunderland.
61 Granite with blue quartz (vein), Sunderland.
62 Talcose schist, Sunderland.
63 Talcose schist with iron pyrites, Sunderland.
64 Brown quartz with iron pyrites, Sunderland.
65 Quartzose rock, Sunderland.
66 Conglomerate containing pebbles of blue quartz, Sunderland.
67 White quartz sandstone, Sunderland.
68 Quartz reddened by fire, Sunderland.
69 *Scolithus linearis* (Hall), in quartz, Sunderland.
70 White quartz, Sunderland.
71 Jointed quartz, Sunderland.
72 Reddish brown sandstone, East Arlington.
73 Granular quartz, East Arlington.
74 Glass sand (tertiary), Sunderland.

EOLIAN LIMESTONE.

75 Silicious limestone, East Arlington.
76 Gray limestone, Arlington.
77 White marble, O. & A. D. Canfield's, Arlington.
78 Marble, West & Canfield's east quarry, Arlington.
79 Bluish marble, West & Canfield's middle quarry, Arlington.
80 Marble, West & Canfield's west quarry, Arlington.
81 Silicious limestone, Arlington.
82 Marble, McKee's quarry, Arlington.
83 Dark silicious limestone, Arlington.
84 Gray silicious limestone, West Arlington.
85 Gray seamy limestone, West Arlington.
86 Black silicious limestone, West Arlington.

TALCOID SCHIST AND CLAY SLATE.

87 Greenish talcose schist, West Arlington.
88 Talcose schist, West Arlington.
89 Green clay slate, West Arlington.
90 Waved clay slate, West Arlington.

91 Porous quartz, (vein), West Arlington.
92 Clay slate, West Arlington.
93 Talcose schist, State line.
94 Talcose schist, Shushan, N. Y.
95 Clay slate, Shushan, N. Y.

APPENDIX TO SECTION III.

96 Calcareous quartz, East Manchester.
97 Calcareous quartz, Factory Point, Manchester.
98 Dark calcareous quartz below No. 97, Factory Point, Manchester.
99 Dark calcareous quartz below No. 97, with chert, Factory Point, Manchester.
100 Gray marble, South Manchester.
101 Consolidated gravel, Dover.

SECTION IV.

The Fourth Section commences at Bellows Falls; passes through Rockingham, Grafton, Windham, Londonderry, Landgrove, Peru, Dorset and Rupert, terminating at the State line, making a length of not more than 56 miles. It is represented upon Plate XV.

Opposite Bellows Falls upon the New Hampshire side is a steep mountain known as Kilburne Peak. It is composed of granitic gneiss, described as the Connecticut River range of gneiss in Part III. It is filled with so many divisional planes that it is difficult to ascertain the true position of the strata. Those planes which most resemble strata dip 26° north-easterly, having the direction N. 50° W.

Veins of granite are common in these ledges, one of which is four feet in width; and its lithological character agrees better with the granite east of Connecticut River, in Massachusetts, than with that found elsewhere in Vermont. Beautiful crystals of wavellite, fluorspar, calcite and tourmaline occur in the gneiss at Bellows Falls. This gneiss is limited in Vermont, the whole of it not covering more than two miles square of surface. We could not find the quartz rock that was seen in Vernon west of the gneiss; and therefore the next rock formation is the clay slate. This upon the road to Saxton's River village at its first outcrop, dips 34° E., with the direction N. and S. North of Bellows Falls we are quite sure that both the gneiss and the slate are nearly perpendicular, at their point of union.

Two and a half miles west of Bellows Falls, the clay slate dips 50° E., with the direction N. 10° E. Further on it dips 80° W., and at Saxton's River village—its western limit—it is inclined 85° E. As is usual upon this rock, beautiful drift striæ are found, and the remarkably fine terraces lining the Connecticut River valley are fully described under Surface Geology.

Numerous veins of hyaline quartz occur at Saxton's River, and the last observed ledge of clay slate has the direction N. 20° E., and the dip 68° E. The average dip of the calciferous mica schist, between Saxton's River and Cambridgeport, is 60° E., and its direction N. 20° E. This rock has very little width upon this section, gneiss taking its place. It is not unlikely that it formerly may have extended over the gneiss formation, or it is higher up in the geological scale; and though it seems to be so thin, it may amount to the whole thickness of the formation, as it would be presented here without plication. A hasty estimate of its thickness here would make it at least 4800 feet, which is surely as thick as we should *wish* to estimate the whole formation.

At Cambridgeport, near the west line of Rockingham, gneiss and hornblende schist occur with the same strike as the overlying mica schist, and a dip of 56° E. Leaving Cambridgeport our road leads us up a high hill to the well known Smith and Goodrich quarries of steatite, on the line of Grafton and Athens. The gneiss on the road is noticeable for its distinctness, an unusual amount of feldspar being present, sometimes in the form of nodules. East of the steatite it runs N. 30° E., and dips 42° E., and resembles somewhat the constituents of the granite of Stamford. The Goodrich quarry of steatite lies north of that of Smith, both running N. 50° E. There are great irregularities in them, in respect to the position of the steatite and associated rocks. Also the adjacent ledges are somewhat disturbed, as the gneiss rock north of Goodrich's quarry shows, its direction being N. 70° E., and the dip 36° northerly. We must refer to the detailed description of these beds for all the particulars. We would only say in passing, that the rocks are working round to form an anticlinal, and that these quarries are not far from its center.

On account of the roads we next went to Townshend, somewhat away from the line of the section. At the south line of Athens there is a bed of limestone or dolomite in a line between the steatite just mentioned, and another bed in Townshend. It contains talc and other minerals, usually associated with steatite, as hornblende, chlorite, epidote and tourmaline. The dolomite presented a rich variety of colors—white, grayish-white, gray, brown, straw-color, red, green, and one or two nondescripts. It is a fine place to obtain attractive cabinet specimens. The bed is twenty-five feet wide, its dip 48° N.W., and it is made by the proprietor, Wm. Holbrook, to yield from 600–800 barrels of lime annually. In the vicinity, other small beds of limestone occur. It should be noticed that this bed, and the steatite of David Bemis' farm two miles south, have the same dip and strike, and are on the west side of the anticlinal.

In the north part of Townshend the strike of the gneiss is N. 25° E., and the dip is 60° W. Occasional beds or strata of limestone are frequently met with, and in this respect it bears a slight analogy to the calciferous mica schist formation. In the south-west corner of Grafton the gneiss dips east, thus forming a synclinal axis.

Just over Windham line, on Simeon Pierce's farm, is a large bed of steatite, also in the gneiss. The most constant direction is about north and south, and the dip 50° E. There is a locality of unusually fine crystals of green actinolite at the south end of this bed. Seventy-five rods west of Pierce's bed, and separated by hornblende schist, is a hill of slaty serpentine 40 rods wide, upon Asa Whitman's land. The strike is N. and S., the dip on both sides is 60° E., garnetiferous schists lying upon the west. North of these beds we saw hornblende schists with the same strike, dipping 36° E. This bed must be in the gneiss, because further west there are several ledges of gneiss running N. and S., with the dip of 40°. It is slaty and is evidently a mongrel between gneiss and talcose schist.

The first distinct talcose schist dipped 46° E., and had the direction N. 15° E. In the vicinity of Windham there are several large beds of steatite and serpentine, viz.: A great hill of serpentine east of the church, John Greely & Co.'s hill of serpentine, one and a half miles north of Windham Center, running N. 10° E. and inclined 60° E.; and two beds of Abel Putnam's half a mile north of Greely & Co.'s, the western one being 12 rods wide and composed of both minerals, the eastern one being mostly steatite.

East of these beds is a fine locality of garnet; and striæ are found running down the valley of Saxton's River, much in the manner of striæ by glaciers.

Passing over high mountains into the east part of Londonderry, the gneiss of the Green Mountains appears running N. 15° E., with the dip of 60° E., and in it is a bed of white feldspathic rock, three feet wide, labelled Eurite in the Cabinet (No. $\frac{4}{80}$.) A mile west there is found quite a large amount of syenite and granite, evidently eruptive — much of the granite is epidotic (Nos. $\frac{4}{84}$, $\frac{4}{85}$.) The gneiss now begins to be very marked in its character, containing much feldspar, and frequently much hornblende. One and a half miles east of North Londonderry the strike is N. 10° E., and the dip is 40° E. Near the village it dips 8°E., and the horizontality may be seen just west of the village. Moraine terraces of a peculiar curved character, besides the ordinary forms, may be seen in this vicinity.

At about the center of the anticlinal the gneiss contains many talcky seams (No. $\frac{4}{93}$.) In Landgrove the strata dip 25°W.; and from this ledge to an exposure in the extreme west part of Peru, west of the summit of the Green Mountains, about six miles, no rock was found in place in Peru. But in the northwest part of Winhall, nearly upon the route of the Section, there are ledges; at first dipping 70°–75° southerly, then N. 80° W., and then west at a smaller angle. There is, then, both a synclinal and anticlinal axis in the gneiss in Peru.

At Wood & Brown's saw mill, in West Peru, gneiss and curiously contorted hornblende schist were found dipping 38°W., with the direction of N. 30° E.,— a part of these ledges are much divided by jointed planes. West of the saw mill upon the mountain is the quartz rock, nearly horizontal. As the mountain is nearly perpendicular on the western side, there was afforded an excellent opportunity of measuring the thickness of the formation; which will be correct, excepting whatever portion may have been eroded by drift and other agencies. Our measurements made a thickness of 973 feet to the quartz rock, of which the lower 266 feet were somewhat schistose, and the remainder was a massive vitreous sandstone. The quartz rock evidently lies upon the gneiss uncomformably. If so it must be newer than the gneiss.

At the base of the quartz rock the strata dip perceptibly eastward, about 10°–15°. The junction between this rock and the apparently underlying Eolian limestone is as usual covered with loose materials. In this case these materials are of tertiary age. Hematite and glass sand are abundant in these deposits in East Dorset.

The first limestone seen dipped east at an angle of 65°–85° E., with the direction N. 20° E. This stone is white, containing crystalline bunches of quartz and calcite, the latter being fetid. A black argillaceous limestone with a high dip intervenes between this ledge (near the end of the famous "Spout") and the village of East Dorset, and the dip diminishes in inclination.

Next we ascend Mount Eolus, and we will mention a few general facts concerning the structure of the mountain, referring elsewhere for the details. At the railroad track the imestone dips 15° N.E.; this angle becomes less, dipping 10° N.W. and lying horizontal, before reaching the marble quarries, and all the strata are limestone. At Holley, Field and Kent's great opening the strata are horizontal. At the cave the saccharoid limestone dips 8° W. This cave is a remarkable proof that the valley east was once filled up with limestone to the height of 1770 feet above East Dorset. The highest bed of limestone, which is of a blue compact character, is over 1900 feet above the valley, with the same dip as the rock at the cave, hence the thickness of the limestone in Dorset Mountain is more than 1900 feet.

The top of Mount Eolus is composed of talcoid schist with the direction N.E. and S.W. and N.W. dip of 12°. Passing down the west side of the mountain an easterly dip was discovered. And at the first ledge of limestone noticed, the dip is 24° E. with the direction N. 20° E. Thus Mount Eolus is composed of limestone, capped with talcoid schist; the whole being arranged in the form of a basin. The section will show this structure at a glance, and the valleys upon both sides of it will give some idea of the vast amount of rocks that have been eroded from them.

A few small deposits of kaolin, etc., are found upon the west side of the mountain, and are referred to the same age with those upon the east side.

Near West Dorset there is a ledge of red limerock dipping 14° south, with the strike, N. 85° E. The marble is invariably found near the top of the limestone formation, which runs around the south end of the mountain into West Dorset and Manchester; and as the west side of the synclinal is the lowest, the marble is quarried extensively in the west valley. The number of marble quarries about Mount Eolus is very great.

North of West Dorset, at Wm. Sykes' house, the limestone runs N. 30° E. and dips 20° southeasterly. This valley is filled with alluvial products, and does not therefore exhibit many of the older ledges. The next formation begins to appear upon the town line between Dorset and Rupert, and it is composed of talcoid schist and clay slate. They form a mountain, which extends far north and south into the Taconic range. At the foot of the mountain the rock is talcoid schist with the dip 12° E., and the strike of N. 40° E. A half a mile west is the same rock, dipping 30° S.E. and running N.E. and S.W. Before reaching the top of the mountain we saw these variations: talcoid schist one mile from the top, dip 37° E., strike N. 20° E; further west, same rock with the dip 50° E., and the strike N. 30° E.; at Mr. Tobin's house strata, of clay slate two rods wide; and a quarter of a mile further is another bed of clay slate, one-eighth of a mile in width. At the top there is a bed of blue compact limestone three feet wide. For two miles no rock occurs *in situ*, but we doubt not it is mostly talcoid schist over this line, as there is a very characteristic green talcose schist on the west side of the mountain, a mile and a half east of Rupert depot. Near the depot the great Georgia slate formation appears in fine development; the dip being 55° E. and the direction N. 15° E.

Drift striæ are exhibited in rich profusion upon all these ledges, as upon clay slate everywhere in the State. This is the first section upon which we have gone far enough west in Vermont to reach the real roofing slate. Its great regularity of strata cleavage (?) and its varying colors of bright-red, green, chocolate, slate, etc., make it an interesting group of rocks to study. For our opinion respecting their age we refer to GEORGIA SLATE.

SPECIMENS ILLUSTRATING SECTION IV.

GNEISS.

1 Gneiss, Bellows Falls.
2 Gneiss, Bellows Falls.
3 Granite (vein), Bellows Falls.
4 Granite, feldspar abundant (vein), Bellows Falls.

CLAY SLATE.

5 Clay slate, Bellows Falls (north.)
6 Weathered clay slate, Westminster, north line.
7 Clay slate, North Westminster.
8 Clay slate, with garnets, Rockingham.
9 Clay slate, with garnets, Rockingham.
10 Clay slate, Saxton's River village.
11 Hyaline quartz (vein), Saxton's River village.
12 Argillo-mica slate, Rockingham.

CALCIFEROUS MICA SCHIST.

13 Silicious limestone, Rockingham.
14 Mica schist, passing into gneiss, Rockingham.
15 Red granite (bowlder), Rockingham.
16 Red granite (bowlder), Rockingham.

GNEISS.

17 Hornblendic gneiss, Cambridgeport.
18 Thick-bedded gneiss, Cambridgeport.
19 Hornblendic schist, Cambridgeport.
20 Hornblendic gneiss, Cambridgeport.
21 Hornblendic gneiss, Cambridgeport.
22 Hornblende schist, Cambridgeport.
23 Gneiss, Grafton.
24 Hyaline quartz (vein), Grafton.
25 Coarse gneiss, Grafton.
26 Gneiss, overlying Smith's steatite, Grafton.
27 Hornblende (massive), overlying Smith's steatite, Grafton.
28 Talcose schist, interstratified with steatite, Grafton.
29 Talcose schist, interstratified with steatite, Grafton.
30 Chlorite and talc, Smith's quarry, Grafton.
31 Steatite, Smith's quarry, Grafton.
32 Steatite, Smith's quarry, Grafton.
33 Gneiss, overlying Goodrich's steatite, Grafton.
34 Hornblende rock, overlying Goodrich's steatite, Grafton.
35 Talcose schist, overlying Goodrich's steatite, Grafton.
36 Talcose schist, overlying Goodrich's steatite, Grafton.
37 Steatite from the upper bed, Goodrich's quarry, Grafton.
38 Hornblende schist, between beds of steatite, Goodrich's quarry, Grafton.
39 Steatite from the lowest bed, Goodrich's quarry, Grafton.
40 Talcose schist, southwest part of Goodrich's quarry, Grafton.
41 Chlorite, with brown spar, southwest part of Goodrich's quarry, Grafton.
42 Steatite, west end of Goodrich's quarry, Grafton.
43 Hornblende, west end of Goodrich's quarry, Grafton.
44 Contorted talcose schist, west end of Goodrich's quarry, Grafton.
45 Talc, west end of Goodrich's quarry, Grafton.
46 Disintegrating talcose schist, west end of Goodrich's quarry, Grafton.
47 Gneiss, Holbrook's limekiln, Townshend.
48 White dolomite, Holbrook's, Townshend.
49 Hyaline quartz (vein in dolomite), Townshend.
50 Gneiss, with green feldspar, Townshend.
51 Steatite, Bemis' bed, Townshend.
52 Impure steatite, Bemis' bed, Townshend.
53 Gneiss, Townshend Center.
54 Gneiss, N.W. Townshend.
55 Gneiss, east side of Pierce's soapstone, Windham.
56 Steatite, S. Pierce's bed, Windham.
57 Impure steatite and brown spar, Windham.
58 Hornblendic gneiss, Windham.
59 Quartz (vein), Windham.
60 Serpentine, A. Whiteman's, Windham.
61 Hornblendic gneiss, Windham.
62 Gneiss, Windham.

TALCOSE SCHIST.

63 Talcose schist, Windham.
64 Talcose schist, Windham.
65 Compact talcose schist, Windham Center.
66 Hyaline quartz (vein), Windham Center.
67 Talcose schist, with iron ore, Windham Center.
68 Talcose schist, Windham.
69 Garnets in talcose schist, Windham.
70 Hornblende rock, Putnam's steatite, Windham.
71 Steatite, east side of Putnam's bed, Windham.
72 Steatite, east side of Putnam's bed, Windham.

73 Steatite, west side of Putnam's bed, Windham.
74 Steatite, west side of Putnam's bed, Windham.
75 Serpentine, Putnam's bed, Windham.
76 Serpentine, Greely's bed, Windham.
77 Talcose schist, Windham.
78 Talcose schist, Windham.

GNEISS.

79 Feldspathic mica schist, East Londonderry.
80 Eurite (?) East Londonderry.
81 Feldspathic mica schist, East Londonderry.
82 Syenite, East Londonderry.
83 Granite, East Londonderry.
84 Epidotic granite, East Londonderry.
85 Epidotic granite, East Londonderry.
86 Hornblendic gneiss, Londonderry.
87 Gneiss, Londonderry.
88 Schistose hornblende, Londonderry.
89 Hornblende, Londonderry.
90 Gneiss, North Londonderry.
91 Gneiss, North Londonderry.
92 Gneiss, North Londonderry.
93 Gneiss with talcy seams, West Londonderry.
94 Hornblende schist, Landgrove.
95 Gneiss, Landgrove.
96 Hornblende schist, Landgrove.
97 White gneiss, Peru.
98 White gneiss, Peru.
99 Gneiss, Peru.
100 Gneiss, West Peru.
101 Jointed hornblende schist, West Peru.
102 Gneiss, West Peru.
103 Contorted hornblende schist, West Peru.
104 Contorted hornblende schist, West Peru.

QUARTZ ROCK.

105 Quartz sandstone, West Peru.
106 Brown quartz, West Peru.
107 Compact bluish quartz, West Peru.
108 Quartz reddened by fire, East Dorset.
109 Brown shaly quartz, East Dorset.
110 Quartz conglomerate (bowlder), East Dorset.

PLIOCENE TERTIARY.

111 Glass sand, East Dorset.
112 Glass sand with glassy quartz, East Dorset.
113 Glass sand, East Dorset.
114 Glass sand, East Dorset.
115 Red kaolin, East Dorset.
116 Hematite, East Dorset.

FROM A DIKE IN SILICIOUS LIMESTONE.

117 Lithomarge, North Dorset.
118 Lithomarge, North Dorset.
119 Lithomarge, North Dorset.
120 Lithomarge, North Dorset.
121 Lithomarge, North Dorset.
122 Brecciated lithomarge, North Dorset.
123 Brecciated lithomarge, North Dorset.
124 Brecciated lithomarge, North Dorset.
125 Brecciated lithomarge, North Dorset.
126 Ferruginous rock from the side of the dike, North Dorset.
127 Lithomarge.

EOLIAN LIMESTONE.

128 Calcareous quartz containing the lithomarge dike of North Dorset.
129 Silicious limestone, S.W. Mount Tabor.
130 Calcareous sandstone, East Dorset.
131 Silicious limestone, East Dorset.
132 White silicious limestone, East Dorset.
133 Dark argillaceous limestone, East Dorset.
134 Gray silicious limestone, East Dorset.
135 Limestone with slaty seam, Mount Eolus.
136 White limestone, Mount Eolus.
137 Gray decomposing limestone, Mount Eolus.
138 Bluish limestone, Mount Eolus.
139 Silicious limestone, Mount Eolus.
140 Gray marble, Mount Eolus.
141 White marble,—Holley, Field & Kent, Mt. Eolus.
142 Impure marble,—Holley, Field & Kent, Mt. Eolus.
143 Nodule of Greenstone, Mount Eolus.
144 Saccharine marble, cave, Mount Eolus.
145 Marble from the bottom of the cave, Mt. Eolus.
146 Silicious gray limestone, Mount Eolus.

TALCOID SCHIST.

147 Talco-argillaceous slate, Mount Eolus.
148 Talco-argillaceous slate, Mount Eolus.
149 Talcose schist, Top of Mount Eolus.
150 Talco-argillaceous slate, west side of Mount Eolus.

EOLIAN LIMESTONE.

151 Bluish-gray limestone, Mount Eolus.
152 Red silicious limerock, Dorset.
153 Silicious limestone, Dorset.
154 Gray silicious limestone, Dorset.
155 Clouded marble, R. P. Bloomer's, Dorset.
156 White marble, R. P. Bloomer's, Dorset.
157 White marble, R. P. Bloomer's, Dorset.
158 Bluish-gray limestone (in the fold),—Way, Wilson & Co., Dorset.
159 White marble disturbed by the fold,—Way, Wilson & Co., Dorset.
160 White marble,—Way, Wilson & Co., Dorset.
161 White marble, M. & G. B. Hale, Dorset.
162 White marble, Armstrong's, Dorset.
163 Blue limestone with pyrites, Armstrong's, Dorset.
164 Silicious limestone, Armstrong's, Dorset.
165 Red limerock, Armstrong's, Dorset.
166 Compact gray limestone, Dorset.
167 Friable gray limestone, N.W. Dorset.

TALCOID SCHIST.

168 Talco-argillaceous slate, Rupert.
169 Talcose schist, Rupert.
170 Hypozoic gneiss (bowlder), Rupert.
171 Porous quartz (vein), Rupert.
172 Talcose schist contorted, Rupert.
173 Gneiss (bowlder), Rupert.
174 Gneiss (bowlder), Rupert.

GEORGIA GROUP.

175 Clay slate, Rupert.
176 Clay slate, Rupert.
177 Green clay slate, Rupert.
178 Green clay slate, Rupert.
179 Red sandstone (bowlder), Rupert.
180 Reddish clay slate, Rupert.
181 Reddish clay slate, Rupert.

APPENDIX TO SECTION IV.

182 Compact quartz rock, west Mount Tabor.
183 Slickensides on limestone, Kelly's west quarry, Danby.
184 Red breccia, Kelly's west quarry, Danby.
185 Red breccia, Kelly's west quarry, Danby.
186 Trap (dike), Kelly's east quarry, Danby.
187 Amygdaloidal trap, Kelly's east quarry, Danby.
188 Junction of trap dike with limestone, Kelly's east quarry, Danby.
189 Marble between dikes, Kelly's east quarry, Danby.
190 Marble, Symington's quarry, Danby.
191 Talcose schist (same in limestone), Danby.
192 Talcose schist, Danby.
193 Talcose schist, Danby.
194 Sparry limestone, east of Pawlet.
195 Red and green argillaceous slate, North Pawlet.
196 Slaty limestone, East of Pawlet.
197 Green clay slate, North Pawlet (Algiers.)
198 Clay slate, west of Pawlet Center.
199 Reticulated quartz veins in gray grit, Granville, N. Y.
200 Steatite, B. Warren's, Ludlow.
201 Quartz found in No. 192.
202 Silicious limestone overlying quartz, S.W. Mount Tabor.
203 Stalactite, Danby.
204 Stalactite, Danby.
205 Stalagmite, Danby.
206 Claystones, Danby.
207 Claystones, Danby.

SECTION V.

This Section commences at Connecticut River, in Windsor, passes through the south part of Windsor, the northwest part of Weathersfield, Cavendish, Ludlow, Mount Holly, Wallingford, Tinmouth and Wells, terminating at the west line of the State. It is 41 miles long, and is represented upon Plate XVI. At the eastern end of the Section, Mount Ascutney looms up in beautiful grandeur, and its geological structure is very interesting. It is an erupted mass of syenite and associated rocks. East of the mountain, upon the west bank of Connecticut River, there is a narrow belt of calciferous mica schist, with white quartz veins, and a few layers of clay slate. One mile below Windsor, upon Connecticut River, the dip of this rock is 43° E., and the strike N. 25° E., but the layers are very much contorted, with evident marks of disturbance. Near Cyrus Beckley's house on the line between Windsor and Weathersfield, the same rock dips 60° E., with the direction N. 10° E. These schists are more than a mile wide. Then we pass upon the syenite and there is nothing but an expanse of syenite all over the conical peak of Ascutney, and it is this that presents so white an aspect to the mountain at a distance. By referring to the Map it will be seen that this syenite extends east and west several miles, while its north and south diameter is very short. It would appear then that there was a great crack or fault opened across the strata, into which the melted syenite was erupted, and the force of the eruption increased the width of the opening. But there must have been a former extension of the walls of schist, at least 2000 feet above their present occurrence, upon both sides of this ancient lava, else it had spread over the valleys adjacent. Any one familiar with the position of these rocks can see that the syenite is immensely developed far above the schists; and thus will appreciate the value of this test as an evidence of the amount of erosion.

Upon examining the ledges immediately contiguous to the granite, we find most powerful marks of alteration by heat. Everywhere that we have approached the syenite it has been surrounded from a quarter to half a mile with indurated schists that ring like pot metal when touched with a hammer,—and the limerock that is usually arranged in separate strata, seems to have become a constituent part of each stratum, the whole rock resembling the compact vitrified quartz west of the Green Mountains. Often crystals of staurotide, and perhaps scapolite, are formed in the schist by the heat. In the west part of the larger mountain there are enormous veins crawling round in all conceivable directions in former crevices among the schists. These are well shown at a waterfall near J. A. Strow's house 1940 feet below the summit, where a stream falls over the end of a dike 61 feet high, and ten rods wide. The altered schists near this dike dip 44° E., having the direction N. 30° W.

This syenite is full of nodules of hornblendic masses, which look in some cases much like pebbles. They are probably concretionary, and are all allied to the concretions of black mica in granite at Craftsbury and elsewhere.

In the west part of Weathersfield and Windsor, the adjacent rocks change from mica schist to gneiss; and west of this line of demarkation the syenite is very narrow, but it soon spreads out again into the hill known as Little Ascutney. This hill is composed of conglomerate, porphyry and granite. There seems to have been a melting up of the conglomerate into the other two varieties of igneous rocks; it being shown elsewhere that

upon the top of the hill there is a ledge of which one end is conglomerate, the middle porphyry, and the other end granite, without any seam between. This conglomerate is of an unknown age. There is no other rock like it in the Connecticut valley, except a conglomerate of oolitic age, and we are not yet ready to believe that this ledge is as recent as the oolite.

Leaving the syenite we find gneiss running under it on the west side at a small village sometimes known as Greenbush. Beds of limestone are frequent in the gneiss in this region, old kilns meeting one's view continually. The principal beds are at Amsden's mill, Craigue's quarry, in Weathersfield, and the Upper Falls in Black River in Cavendish.— We regard these beds as belonging to the same bed, and those with opposite dips as being on different sides of an anticlinal, which, according to our section, is repeated. Thus there might be four beds over a space of two miles belonging to the same belt. Not far from these beds, and probably upon the same strike, in Baltimore, there is a fine bed of steatite which is being profitably quarried.

At Amsden's mill the east flank of the anticlinal runs N. 30° E. and dips 60° E. The west flank has the same strike and the same degree of dip, but the dip is smaller upon both sides at a short distance from the center of the fold. The strike varies 30° from Strow's house in Weathersfield, about two miles distant. Craigue's quarry of limestone has brought to view two drap dikes, composed of concretionary nodules, which lean towards each other like the strata on the opposite sides of an anticlinal.

At Downer's tavern in Weathersfield, the gneiss runs N. 10° W. At a saw mill, one and a half miles from the town line, the dip is 7° W. At the town line, the gneiss dips 14° E. The valley of Black River is very narrow; there are no terraces upon its banks, and the bed of the stream is full of large bowlders. By the constant wearing of water, the bowlders have assumed various shapes. One large one is hollowed out like a bell; and it is usual to see the lee side apparently the most worn portion of the block, as if the work was performed by the eddying of the water around the stone.

Along the river to a saw mill (known as New City), the rock is gneiss, often with a little feldspar, with an invariably small dip, sometimes to the east, and most generally to the west. At Upper Falls there is a good locality of tremolite. At Slab City there is a small band of mica schist. But near Cavendish Center this rock is developed the best. It here contains garnets, staurotide, &c., and the micaceous character is unusually well seen. It underlies the dolomite at Cavendish, and may be traced near the route of the railroad to Gassett's station, and it probably extends further. We consider it, however, as a part of the gneiss formation. It dips 32° W. and runs N. 20° E. at Cavendish.

Black River flows to the north half a mile below Black River Falls, probably because the rock that has been removed was very easily decomposed, consisting of dolomite. This possesses the usual variable colors of white, red, yellow, etc., that are found in beds of this description, and the quantity of stone is quite large. Its dip corresponds with that of the underlying mica schist. Not far from it is a trap dike, which contains crystals of olivine, though not in as great perfection as certain specimens found in bowlders in Thetford.— Still it shows the origin of the mineral unequivocally.

In Cavendish and Proctorsville the Surface Geology is unusually interesting, and those who are particularly interested in that branch will find the facts described under terraces and old river beds.

Gneiss is the prevailing rock between these two villages, and it is well characterized. The dip rises from 30° W. to perpendicular, with a few minor varieties, all of which are carefully protracted upon an enlarged section, in Plate XVI. There would appear to be two other axes within this short distance. West of Gov. Fletcher's house there is a thickness of a few rods of the calciferous mica schist. It has been traced from this point through the Proctorsville gulf to the north part of Chester.

West of the mica schist comes the talcose schist. At first there are several varieties, as the following:

Hornblende schist, dip 80° E., with the direction N. 17° E.
Decomposing talcose schist.
Hornblende schist, dip 80° E., in considerable amount.
Gneiss, dip 58° E., with strike N. 5° E.
Hornblende and talcose schist, dip 55° E.
Gneiss with hornblende schists, dip 75° E.
Concretionary granite vein, less than two rods wide, dipping with the adjacent strata (Nos. $\frac{5}{90}$, $\frac{5}{92}$.)
Gneiss much like quartz rock, two rods wide, dipping 58° E., with the direction N. 10° E. (No. $\frac{5}{95}$.)
Talcose schist, dipping from 66° E. to 90°, with some remarkable contortions, and upon it a curious bowlder (No. $\frac{5}{91}$.)
Talcose conglomerate.
Steatite, belonging to Elder Freeman.
Serpentine of great extent from which excellent verd-antique serpentine has been quarried.
Steatite.
Talcose schist.
Steatite.
Serpentine.
Steatite; and then talcose schist without variation.

This brings us into the eastern edge of Ludlow. Excepting a trap dike, the talcose schist continues to near the west line of the town. In the east part of the town, the dip is 79° E., and the direction N. 24° E. Near Ludlow village the dip is the same, but the strike has changed to N. 15° E. East of the village there is a bed of talcose conglomerate. West of the village the dip is 60° E., with the same strike. Whetstone schist is found in this formation in great abundance. Near the western line of the schist there is an impure bed of steatite, and also of dolomite. The talcose schist adjacent dips 55° E.

At the west line of Ludlow there is a large ledge of quartz rock, dipping 55° E., which is probably connected with the quartz rock in Plymouth.

Next comes the gneiss formation, which is finely exposed in the long railroad cut at Mount Holly. The dip is from 60°–70° E., increasing westwardly — several large trap dikes show themselves cutting the gneiss. Most of them are calcareous, as are also many of the specimens of gneiss that were obtained. The gneiss is obscure, and with it are associated many beds of compact hornblende schist, almost trappean. A multitude of facts are given, respecting these rocks, in the Catalogue and elsewhere in the Report.— The Catalogue of the Sections is an excellent place to find the kinds of rocks that occur in succession, from east to west, as the most scrupulous care has been taken to represent them on the shelves in the order of their occurrence in nature.

Striæ are found running east and west, near the railroad cut upon the east side of the mountain, which are perhaps the result of glaciers.

The rocks are greatly contorted in Mount Holly, and the strike accordingly varies much. At the east end of the railroad cut it is N. 20° E. West of the cut it is N. 12° W.; and very soon it is N. 12° E. Near Mount Holly station the strike is N. 80° W. Between this station and Healdville (east), obscure gneiss dips 40° E. West of Healdville there is hornblende schist dipping 46° southeasterly, with the strike N. 36° E. Though a great portion of the strata receive this name, it is generally not well characterized. This locality shows the two minerals, hornblende and quartz, the most distinctly.

Small beds of limestone are occasionally seen, especially in the west part of the town. Although there are irregularities in the position, we think there is an anticlinal axis in the gneiss of Mount Holly and Wallingford. A careful examination of this part of the section was made in 1860, in company with the class of 1861 of Amherst College.— The section measured at that time is represented in figures. The following brief notes will express the position of the strata of gneiss west of Mount Holly summit station. Near the station house the strata are very much contorted. Some of the strata are inverted. The dip averages from 20°–40° E. There are several obscure ledges of hornblendic gneiss between this station and the village of Mount Holly. One of them gives the strike N. 75° W., and a dip of 85° southwesterly. Near the church the strike is N. 12° E.

At Bowlsville the strata dip from 35°–40° E. A mile or so west of Bowlsville at a cut in the rock for the railroad the hornblende rock dips 10° S. and 10° W. This is very near the center of the axis. The area west is not as great as that east of the center, but the dip is greater, so that the strata are equally thick upon both sides of the axis. West of East Wallingford station the gneiss at one place runs east and west, standing upon its edges, and at another place it dips 40° W. On top of the hill west of the station the strike is N. 20° E., and the dip is 54° W. Between this ledge and the western edge of the formation, made the following measurements in their order: 57° W., 55° W., 56° W., 61° W., N. 70° E., 65°–70° southerly; 75° W., 75° W., 90°, 70° E., N. 30° E., 90°, N. 15° E., 68° W. The last is immediately contiguous to the conglomerate. There are several beds of limestone in Wallingford, in the gneiss. One of them is eighteen feet wide. Four others of smaller width are in the vicinity of D. Hager's house. Two of them appear in a gorge, in which the last of the gneiss is seen. The dip of the conglomerate next west of the gneiss is from 65°–85° W., and its strike is about north and south. A small stratum of mica schist overlies a part of this conglomerate.

The quartz formation has one of its members finely developed in Wallingford — the conglomerate. The pebbles composing it are remarkably distinct, and from the size of grains to twenty inches in diameter. Those of the size of a hen's egg are numerous and are nearly all oval or elongated. Beds of sandstone or talcose schist are interstratified with the conglomerates, and thus the dip and strike may be obtained with accuracy.— Some of these ledges which are upon the south side of a tributary of Otter Creek, have received the name of white rocks from their color. Mr. Hager has proposed the name of calico rocks for some equally striking ledges of variegated color in the vicinity.

The west part of this formation as usual, is obscured by overlying drift deposits and beds of hematite, etc. Hyaline quartz appears one mile east of North Wallingford, running N. 20° W., and dips 20° E. Limestone is the next rock. Most of it dips west beneath the talcoid schists. Marble quarries are found in Wallingford of very good quality; and above them is a rock very much like the brecciated limestone of Plymouth (Nos. $\frac{5}{205}$, $\frac{5}{206}$.)

There is not a very great thickness of schists. In the Cabinet Nos. $\frac{5}{201}$ to $\frac{5}{215}$ represent them, and they are an assemblage of talcose schist, clay slate, impure limestone and quartzose schists. The general dip is to the east, and sometimes as high as 60° E.

West of this group and underlying it is another quartz formation, apparently of the same age with that in East Wallingford. It lies mostly in Tinmouth, and it is found from Rutland to North Danby. It forms an anticlinal in Tinmouth — the east flank running under the schists and dipping from 30° E.–58° E., with a uniform direction of N. 10° E. The western flank in the southeast corner of Tinmouth dips 75° W. Beds of hematite are found upon the surface of this rock as in Wallingford.

West of the quartz rock occurs the Eolian limestone again, with the upper beds of marble. All the strata dip west. A fault probably exists between this limestone and the great talcoid schist formation to the westward. The marble dips about 40° W.

Upon Furnace Brook in Tinmouth are marks, probably those of an ancient glacier, descending from the south northward.

The talcoid schists at first dipping west (locally), presently dip east. In the northwest corner of Danby the talcoid schist runs N. 30° E. and dips 28° E. In the east part of Wells the same rock runs N. 20° E. and dips 30° E. It has the same position till near Wells Corners, where the strike is N. 10° E. Between Wells Corners and the State line the rock is the clay slate of the Georgia group running N. 30° E., and varying in dip from 55° E. to 85° E. Much of it is soft green clay slate, but the other colors may be seen occasionally.

This section is well illustrated by 236 specimens, which were collected at different times during the Survey.

SPECIMENS ILLUSTRATING SECTION V.

CALCIFEROUS MICA SCHIST.

1 Mica schist, Windsor.
2 Milk quartz (vein), Windsor.
3 Mica schist, Windsor.

SYENITE AND ALTERED SCHISTS.

4 Syenite, Windsor.
5 Porphyry, top of Mount Ascutney, Windsor.
6 Breccia passing into porphyry, near top of Mount Ascutney.
7 Syenite, near top of Mt. Ascutney, Windsor.
8 Conglomerated syenite, Mount Ascutney.
9 Brecciated Syenite, Mount Ascutney.
10 Syenite, Mount Ascutney.
11 Brecciated porphyry, Mount Ascutney.
12 Syenitic granite, Mount Ascutney (west side).

13 Fine syenite, between Mount Ascutney and Little Ascutney, West Windsor.
14 Indurated gneiss, Weathersfield.
15 Calcareous mica schist, Windsor.
16 Indurated mica schist, Windsor.
17 Indurated mica schist, Windsor.
18 Jointed quartz, Weathersfield.
19 Jointed calcareous quartz, Weathersfield.
20 Indurated mica schist (calcareous), Weathersfield.

GNEISS ADJOINING THE SYENITE.

21 Gneiss, Weathersfield.
22 Syenite (dike), Weathersfield.
23 Gneiss, Gulf road, Weathersfield.
24 Feldspathic mica schist, Gulf road, Weathersfield.
25 Nodular gneiss, Gulf road, Weathersfield.
26 Nodular gneiss, Gulf road, Weathersfield.
27 Gneiss, Gulf road, Weathersfield.

METAMORPHIC ROCKS OF LITTLE ASCUTNEY.

28 Diorite (bowlder), Little Ascutney.
29 Breccia, Little Ascutney.
30 Conglomerate, Little Ascutney.
31 Conglomerate, Little Ascutney.
32 Pebble from conglomerate, Little Ascutney.
33 Porphyry, Little Ascutney.
34 Granite, Little Ascutney.
35 Jointed quartz, Little Ascutney.
36 Jointed quartz, Little Ascutney.
37 Tarnished quartz, Little Ascutney.
38 Gneiss, west base of Little Ascutney.

GNEISS.

39 Gneiss, Amsden's Mills, Weathersfield.
40 Dolomite, Amsden's Mills, Weathersfield.
41 Gneiss, Greenbush.
42 Limestone altered by trap, Craigue's quarry, Weathersfield.
43 Limestone altered by trap, Craigue's quarry, Weathersfield.
44 Jointed trap, calcareous, Craigue's quarry, Weathersfield.
45 Nodular trap, calcareous, Craigue's quarry, Weathersfield.
46 Gneiss, Downer's, Weathersfield.
47 Gneiss, Weathersfield.
48 Gneiss, Weathersfield.
49 Hayline quartz (vein), Weathersfield.
50 Garnetiferous mica schist, Cavendish.
51 Gneiss, top of the hill west of Greenbush.
52 Gneiss, Cavendish.
53 White dolomite, Upper Falls, Cavendish.
54 Gneiss, Upper Falls, Cavendish.
55 White gneiss, Upper Falls, Cavendish.
56 Gneiss with black mica, Cavendish.
57 Coarse gneiss, Cavendish.
58 Gneiss, Cavendish.
59 Garnetiferous mica schist, Cavendish.
60 Garnetiferous mica schist, Cavendish.
61 Gneiss, Cavendish.
62 Actynolite schist (bowlder), Cavendish.
63 Dolomite, Cavendish.
64 Crystalline dolomite, Cavendish.
65 Mica and quartz, near Cavendish village.
66 Trap calcareous (dike), east of No. 62.
67 Gneiss, Cavendish village.
68 Gneiss with greenish mica, Cavendish.
69 Fine-grained gneiss, Cavendish.
70 Gneiss, Cavendish.
71 Gneiss, Cavendish.
72 Gneiss, Cavendish.
73 Gneiss, Cavendish.
74 Coarse gneiss, Cavendish.
75 Gneiss, Cavendish.
76 Gneiss, Cavendish.
77 Mica schist, Gov. Fletcher's, Proctorsville.
78 Quartz and mica, Proctorsville.

CALCIFEROUS MICA SCHIST.

79 Green hornblende schist, Proctorsville.
80 Mica schist, Proctorsville.
81 Hornblendic gneiss, Proctorsville.
82 Hornblendic schist, Proctorsville.
83 Hornblendic schist, Proctorsville.

TALCOSE SCHIST.

84 Talco-micaceous schist, Proctorsville.
85 Gneiss, Proctorsville.
86 Talcose schist, Proctorsville.
87 Talcose schist, Proctorsville.
88 Talcose schist, Proctorsville.
89 Hornblende schist, Proctorsville.
90 Concretionary granite, Proctorsville.
91 Thick-bedded gneiss (bowlder), Proctorsville.
92 White granite, Proctorsville.
93 Epidotic granite, Proctorsville.
94 White granite (gneiss ?), Proctorsville.
95 Jointed gneiss, Proctorsville.
96 Talcose schist, Proctorsville.
97 Hornblende schist with fasciculite, Proctorsville.
98 Granular quartz (vein), Proctorsville.
99 Talco-micaceous schist, Cavendish.
100 Talcose schist, Cavendish.
101 Talcose schist, Freeman's, Cavendish.
102 Chlorite with magnetite, Freeman's, Cavendish.
103 Chlorite, Freeman's, Cavendish.
104 Steatite, Freeman's, Cavendish.
105 Talc, Freeman's, Cavendish.
106 Impure steatite, Freeman's, Cavendish.
107 Serpentine, Freeman's, Cavendish.
108 Serpentine, Freeman's, Cavendish.
109 Hornblende schist, Cavendish.
110 Serpentine, Neshobe Co.'s first bed, Cavendish.
111 Steatite, Neshobe Co.'s second bed, Cavendish.
112 Whetstone (talcose) schist, A. Adams', Ludlow.
113 Contorted schist, Ludlow.
114 Talcose schist, Ludlow.
115 Talcose schist, Ludlow.
116 Talcose schist, Ludlow.
117 Chlorite schist, Ludlow.
118 Talcose schist, Ludlow village.
119 Talcose schist, Ludlow.
120 Talcose schist, Ludlow.
121 Talcose schist with quartz vein, Ludlow.
122 Talcose schist with crystals of calcite, Ludlow.
123 Talcose schist, Ludlow.
124 Talcose schist (calcareous), Ludlow.
125 Talcose schist (calcareous), Ludlow.
126 Talcose schist, Ludlow.
127 Talcose schist decomposing, Ludlow.
128 Dolomite, Ludlow.
129 Steatite, (calcareous), L. Lawrence's, Ludlow.
130 Talcose schist, Ludlow.

QUARTZ ROCK.

131 Trap dike calcareous, Ludlow.
132 Trap dike concretionary, Ludlow.
133 Quartz rock, Ludlow.
134 Talcose schist, Ludlow.
135 Slaty quartz, Ludlow.
136 Quartz rock, E. Mount Holly.
137 Quartz rock, E. Mount Holly.
138 Decomposing trap (dike), Mount Holly.
139 Tourmaline (bowlder), Mount Holly.

GNEISS.

140 Hornblende schist with crystals of calcite, Mount Holly, at the east end of railroad excavation at the summit.
141 Gneiss, Mount Holly.
142 Hornblende rock, Mount Holly.
143 Gneiss, (calcareous), Mount Holly.
144 Chlorite schist, Mount Holly.
145 Gneiss (calcareous), Mount Holly.
146 Gneiss (calcareous), Mount Holly.
147 Hornblende schist, Mount Holly.
148 Gneiss (calcareous), Mount Holly.
149 Amygdaloidal trap (dike), calcareous, Mt. Holly.
150 Hornblende schist (calcareous), Mount Holly.
151 Amygdaloidal trap, Mount Holly.
152 Gneiss, Mount Holly.
153 Hornblende rock.
154 Feldspar limestone, Mount Holly.
155 Gneiss, Mount Holly.
156 Trap (dike, calcareous), Mount Holly.
157 Hornblende rock, Mount Holly.
158 Hornblende rock, Mount Holly, west end of the the cut.
159 Gneiss, Mount Holly.
160 Gneiss, Mount Holly.

161 Hornblende rock, Mount Holly.
162 Talcose schist, East Wallingford.
163 Trap, East Wallingford.
164 Gneiss, East Wallingford.
165 Decomposing mica schist, East Wallingford.
166 Limestone (bed), East Wallingford.
167 Talcose schist just east of quartz, Wallingford.
168 Gneiss, (calcareous), Wallingford.
169 Gneiss (calcareous), Wallingford.
170 Micaceous limestone, Wallingford.
171 Impure limestone, Wallingford.
172 Impure limestone, Wallingford.
173 Impure limestone, Wallingford.
174 Talcky limestone, Wallingford.
175 Calcite, gorge, Wallingford.
176 Limestone, gorge, Wallingford.

QUARTZ ROCK.

177 Talcose schist with pebbles of blue quartz, Wallingford.
178 Gneissoid rock, Wallingford.
179 Talcose schist, Wallingford.
180 Talcose schist, Wallingford.
181 Gneiss, Wallingford.
182 Talcose conglomerate (bowlder), Wallingford.
183 Gneiss, interstratified with conglomerate, Wallingford.
184 Gneissoid sandstone, Wallingford.
185 Mica schist, Wallingford.
186 Black tourmaline, Wallingford.
187 Pebble from conglomerate, Wallingford.
188 Conglomerate (bowlder), Wallingford.
189 Conglomerate, Wallingford.
190 Conglomerate, Wallingford.
191 Conglomerate (pebbles elongated), Wallingford.

EOLIAN LIMESTONES.

192 Talcky limestone, North Wallingford.
193 Reddish limestone, North Wallingford.
194 Reddish limestone, East Wallingford.
195 Limestone, Wallingford.
196 Contorted limestone, North Wallingford.
197 Contorted limestone, North Wallingford.
198 Silicious limestone, Wallingford.
199 Blue compact limestone, north of Hall's quarry, Wallingford.
200 White marble, Hall's quarry, S. Wallingford.
201 Bluish marble, Hall's quarry, S. Wallingford.
202 White marble, J. Adair & Bro., S. Wallingford.
203 Marble, with talcky seams, South Wallingford.
204 Silicious limestone (below marble), North Wallingford.
205 Conglomerated limestone, west of Gen. Hall's, South Wallingford.
206 Conglomerated limestone, west of Gen. Hall's, South Wallingford.

TALCOID SCHISTS.

207 Clay slate, South Wallingford.
208 Talcose schist, North Wallingford.
209 Silicious limestone, North Wallingford.
210 Talcose schist, North Wallingford.
211 Ferruginous limestone, Wallingford.
212 Silicious limestone, South Wallingford.
213 Quartzose schist, top of hill west of North Wallingford.
214 Talcose schist, top of hill west of N. Wallingford.
215 Clay slate, Wallingford.

QUARTZ ROCK.

216 Quartz sandstone, second layer above No. 218, Tinmouth.
217 Compact blue quartz, first layer above No. 218, Tinmouth.
218 Slaty quartz, East Tinmouth.
219 White sandstone, East Tinmouth.
220 Quartz, South Tinmouth.
221 Hematite (tertiary), S. Phillips', Tinmouth.

EOLIAN LIMESTONE.

222 Calciferous sandstone, Tinmouth.
223 Silicious limestone, Tinmouth.
224 White marble, Edmunds', South Tinmouth.

TALCOID SCHISTS.

225 Talcose schist, southwest corner of Danby.
226 Green sandstone with quartz vein, Wells.
227 Reddish sparry limestone (bowlder), Wells.
228 Reddish sparry limestone (bowlder), Wells.
229 Talcose conglomerate, Wells.
230 Talcose schist, Wells.
231 Decomposing quartz, vein from 230.
232 Sparry sandstone (bowlder), Wells.
233 Talcose schist, top of Haystack Mountain, North Pawlet.

GEORGIA GROUP.

234 Clay slate, Wells.
235 Clay slate, Wells.
236 Green clay slate, Wells.

APPENDIX TO SECTION V.

GEORGIA GROUP AND TALCOID SCHIST.

237 Clay slate, East Poultney.
238 Green clay slate, East Poultney.
239 Chocolate-colored clay slate, East Poultney.
240 Contorted black slate, Middletown.
241 White limestone (bowlder), North Middletown.
242 Conglomerate, North Middletown.
243 Green clay slate, North Middletown.
244 Fossiliferous limestone, Ira.
245 Black clay slate, underlying No. 244.

FROM CUTTINGSVILLE AND VICINITY.

246 Granite, Cuttingsville.
247 Granite (bowlder), Mount Holly.
248 Granite and trap, Cuttingsville.
249 Tarnished limestone, overlying copperas ore.
250 Limestone, overlying the copperas ore.
251 Limestone, overlying the copperas ore.
252 Junction of pyrites and limestone, Cuttingsville.
253 Mica in concretionary masses, Cuttingsville.
254 Jointed hornblende, ore bed, Cuttingsville.
255 Hornblende rock, west end of the ore bed.
256 Gneiss, underlying the copperas ore.
257 Gneissoid rock, East Clarendon.
258 Gneiss, Shrewsbury.
259 Talcose schist, gorge, Shrewsbury.

ROCKS IN CLARENDON FROM EAST TO WEST.

260 Black silicious limestone (Eolian), East Clarendon.
261 White silicious limestone (Eolian), East Clarendon.

QUARTZ ROCK.

262 Slaty gneiss, East Clarendon.
263 Compact blue limestone, East Clarendon.
264 Compact blue quartz, East Clarendon.
265 Talcose quartz rock, East Clarendon.
266 Talcose quartz rock, North Clarendon.
267 Talcose schist, with quartz, North Clarendon.
268 Granular quartz, center of Clarendon.

EOLIAN LIMESTONES.

269 Gray silicious limestone, Clarendon.
270 Silicious limestone, Clarendon.
271 White silicious limestone, Clarendon.
272 Bluish granular limestone, near Clarendon Springs.
273 Bluish limestone, near Clarendon Springs.
274 Bluish limestone, near Clarendon Springs.
275 Calciferous sandrock, north of Clarendon Springs.
276 Calciferous sandrock, south of Clarendon Springs.
277 Silicious limestone, S.W. Clarendon.

278 Calciferous sandstone, south of Clarendon Springs.
279 Calciferous sandstone, south of Clarendon Springs.
280 Calciferous sandstone, south of Clarendon Springs.
281 White marble, Hyde's quarry, Clarendon Springs.
282 Marble, top layer, Hyde's quarry, Clarendon Springs.
283 Jointed silicious limestone, West Clarendon.
284 Dark silicious limestone, West Clarendon.
285 White marble (lower bed), Colvin's, West Clarendon.
286 Clouded marble (upper bed), Colvin's, West Clarendon.

CLAY SLATE.

287 Clay, West Clarendon.
288 Black clay slate, Ira.
289 Black clay slate, Ira.

SPECIMENS FROM PLYMOUTH, Etc.

290 Breccia, cemented by hematite, Tyson's Furnace.
291 Breccia, mostly quartz, Tyson's Furnace.
292 Breccia, cemented by hematite, Tyson's Furnace.
293 Talcose schist, Plymouth.
294 Granular quartz, Plymouth.
295 Granular quartz, Plymouth.
296 White limestone, Plymouth.
297 Limestone, Plymouth.
298 Silicious limestone, Plymouth.
299 Specular iron, with limestone, Plymouth.
300 Brecciated marble, Plymouth.
301 Steatite, M. Pelton's, Plymouth.
302 Steatite, M. Pelton's, Plymouth.
303 Steatite, A. Bates', Plymouth.
304 Steatite, west of A. Bates', Plymouth.
305 Steatite, Society Lot, Plymouth.
306 Steatite, J. Marsh's, Plymouth.
307 Steatite, Z. Parker's, Ludlow.
308 Talcose schist (gold rock), Plymouth.
309 Gold bearing quartz, Plymouth.
310 Talcose schist, Plymouth.
311 Chlorite schist, Plymouth.
312 Talcose schist, with garnets, Plymouth.
313 Mica schist, Cavendish village.
314 Light colored trap (calcareous), Black River Falls, Cavendish.
315 Silicious limestone, West Windsor.
316 Mica schist, Saunder's mill, West Windsor.
317 Clay slate, Saunder's mill, West Windsor.
318 Bent clay slate, Windsor.
319 Gray clay slate, Windsor.
320 Gray clay slate, Hartland Center.
321 Clay slate, North Hartland.

SECTION VI.

This Section commences at White River Junction, passes through Hartford, the northwest corner of Hartford, Woodstock, Bridgewater, Sherburne, Mendon, Rutland, Ira, Castleton, Fairhaven, and terminates on the shore of Lake Champlain, in West Haven. It is represented on Plate XVI. Upon this Section for the first time, we meet with the Connecticut River range of talcose schist. It generally is nearly perpendicular about the Junction, judging from the region about. A mile and a half southwest of the Junction, the rock is hard talcose schist and porphyritic hornblende. The strike is generally N. 20° E., and the dip varies from 85° E. to 85°W. Much of this formation is a mongrel rock, having often an argillaceous appearance, but it is not slaty. The indurated talcose schist sometimes resembles serpentine, and is also occasionally calcareous. At White River village the talcose schist exhibits its normal character, dipping 70° E., and running N. 30° E. A narrow band of clay slate appears at White River village. It is about a mile wide. Its position is very much the same as that of the talcose schist.

Upon the top of the hill, separating the waters of the Otta Quechee and Connecticut Rivers, mica schist appears. It is a part of the calciferous mica schist which dips 50° E., with the strike N. 20° E. about a quarter of a mile east of Quechee village. At Dewey's factory the strata run N. and S., dipping 50° E. There is a trap dike here half a mile long, five and a half feet wide, running N. 20° E. and dipping 58° E. At Quechee village the strata dip 45° E., and have the strike N. 35° E. Between the village and Woodstock Court House the strata are more irregular. At one place they dip 20° southerly, or with the strike N. 70° W. At Daniel's machine shop west of the Court House, the strike is N. 20° E., and the dip is 34° W., thus constituting an anticlinal axis. A synclinal axis is soon found in proceeding west, for in the west part of Woodstock the strike of the mica schist is N. 20° E., and the dip 30° E. A narrow belt of gneiss is crossed near the Bridgewater line — strike N. 20° E., dip 30° E.

The talcose schist is first met with at Bridgewater village and continues to Sherburne village. Its position at first is strike N. 20° E., dip 30° E. At the gold mine in Bridgewater the dip is 30° E., and the strike N. 20° E. The gold is associated here with galena, automolite, blende, pyrites and chalcopyrite in four veins of quartz which cross the strata nearly at right angles, and dip 65° N. The average thickness of the cross cuts is fifteen inches. Gold is present in the quartz and may be seen occasionally, but it is more abundant in the peroxyd of iron filling the crevices in the rocks. There is a fine bed of steatite in the north part of Bridgewater, which is represented upon the Section. In the southwest part of Bridgewater a narrow bed of brown quartz rock appears, with the strike north and south, and the dip of 40° E. Near the west part of the town there are strata of plumbaginous slate running N. 5° to N. 10° E., and inclined 60° E. In Sherburne village the strike is north and south, and the dip about 60° E. The last stratum of schist, a short distance west of the village, runs north and south and dips 60° E.

In the west part of Sherburne the gneiss dips 50° E., and runs north and south. The tops of Killington Peak and Pico Peak are mostly covered by unmodified drift. We could not determine the position of the strata on top of Pico Peak with satisfaction.— They appear to dip east and run from N. 20° E. to N. 30° E. The strata in the line of strike, two miles north clearly dip 15° E. Most of the west side of the mountain is covered with drift. A large bed of azoic limestone appears in the northeast part of Mendon, with the strike N. 10° E, and the dip of 25° E. It dips southerly at other exposures; also 25° N., with the strike east and west. This rock may exist in too large a mass to be called a bed. We could not determine its extent on account of the obscuration of all the rocks by drift.

The quartz rock forms a mountain range in the west part of Mendon. Talcose schist is associated with it. The dip is generally obscure, but seems to be about 55° E. In the east part of Rutland, a sandy thick-bedded limestone appears dipping 45° E. This is the Eolian limestone. At the Post-office in Rutland the strata dip about 8° E. A little north of the line of the section there is a variety of the limestone slightly resembling the Plymouth marble.

A range of quartz rock shows itself on the line of the section in Otter Creek at Center Rutland, dipping 30° E. Next we come to a narrow range of Eolian limestone dipping east at a moderate angle. The hill east of the West Rutland marble quarries is composed

of argillo-talcoid, and talcoid schists. Their strike is about north and south, and their dip from 20°–30° E.

The section next crosses the beautiful marble quarries in West Rutland. Their average direction is about twenty degrees east of north, and the dip about 40° E. The most southern quarries on the west side of the hill have a higher dip than the more northern ones in Rutland. The inclination increases as the strata descend into the earth. The talcoid schists appear to dip beneath the limestones. Perhaps there may be a fault between them.

The talcoid schists in Rutland, Ira and Castleton almost invariably dip east from 20°–60°. If there be any exception it is on Bird Mountain. Numerous measurements will be found of them as well as of the clay slates in Castleton, Fairhaven and West Haven. These clay slates first appear in the east part of Castleton. They invariably dip east from 10°–60°. Beds of talcoid schist, limestone, quartz rock and sandstone with conglomerate occur in it. Several small faults have been noticed in it at the quarries. In the west part of Fairhaven there is a range of talcoid schist, dipping east. The extent of all these varieties is carefully indicated on the colored section.

Near the west line of Fairhaven the section strikes alternating beds of clay slate and impure limestone, all dipping east. They extend to the Trenton limestone west of the Post-Office in West Haven. As they overlie the Trenton we call them the Hudson River group, the upper member of the lower Silurian group. It is possible that this group ought to be referred to the Georgia group. Lithologically it agrees better with the Georgia than the Hudson River group, except in the presence of so many bands of limestone. It is very singular that the dip is so invariably east from the calciferous mica schist in Woodstock, to the calciferous sandrock on Lake Champlain in this section.

A thin band of Trenton limestone appears about half a mile west of the village of West Haven. It dips 5° E. Its inferior position to the slates east of it is very evident. The dip of the slate is uncertain. Its cleavage planes run N. 30° E., and dip 50° E.

The calciferous sandrock is largely developed in West Haven. Its general dip is 10° E. Its character is well indicated by the specimens in the State Cabinet. The Potsdam sandstone underlies it in the south part of the town, with about the same dip. The character of this rock has been obscured by metamorphosis. Good specimens of hornblende schist, and almost of gneiss are found in it. And a few small veins of granite containing Labradorite are found at the extreme south end of the town. The rock is better developed both in its ordinary character and thickness at Whitehall, N. Y., one mile from Vermont. The Potsdam sandstone may be seen lying unconformably upon Laurentian quartz rock at the south end of West Haven. This Laurentian rock passes into gneiss, and forms a range in Vermont about three miles long. On its west side the calciferous sandrock appears with an easterly dip. Hence there must be a fault between the Laurentian gneiss and the calciferous sandrock.

This is one of the most important and interesting of all the sections. It is the first upon which, in going north, we have found any fossiliferous rocks of undisputed lower Silurian age.

SPECIMENS ILLUSTRATING SECTION VI.

TALCOSE SCHIST.

1 Indurated talcose schist, calcareous, Norwich.
2 Indurated talcose schist, calcareous, Norwich.
3 Reddish indurated talcose schist, calcareous, Norwich.
4 Talcose schist, with calcite, Thomas' mine, Norwich.
5 Talcose schist, with iron pyrites, White River Junction.
6 Gossan (bog iron ore), White River Junction.
7 Talcose schist and limestone, White River Junction.
8 Porphyritic hornblende, Hartford.
9 Talcose schist, White River village.

CLAY SLATE.

10 Argillo-talcose slate, White River village.
11 Clay slate, Hartford.

CALCIFEROUS MICA SCHIST.

12 Jaspery iron ore (bowlder), Quechee village.
13 Brick worn by water (bowlder), Quechee village.
14 Porphyritic trap (dike), Falls of Otta Quechee, Quechee village.
15 Trap (dike), calcareous, Falls of Otta Quechee, Quechee village.
16 Hyaline quartz (vein), N.W. Hartland.
17 Silicious limestone, N.W. Hartland.
18 Argillo-micaceous slate, Woodstock village.

GNEISS.

19 Gneiss, west line of Woodstock.

TALCOSE SCHIST.

20 Talcose schist, Bridgewater.
21 Talcose schist, south side of Wood's soapstone, Bridgewater.
22 Hornblende schist, Wood's steatite ledge, Bridgewater.
23 Steatite, Wood's ledge, Bridgewater.
24 Steatite, Wood's ledge, Bridgewater.
25 Talcose schist, Bridgewater.
26 Ferruginous conglomerate, gold works (alluvial), Bridgewater.
27 Gold bearing quartz, with galena, Bridgewater.
28 Talcose schist, gold region, Bridgewater.
29 Gray quartz, Bridgewater.
30 Talcose schist, Bridgewater.
31 Talcose schist, with garnets, Bridgewater.
32 Talcose schist, with carb. iron, Sherburne.
33 Talcose schist, Sherburne village.
34 Talcose schist, Sherburne village.

GNEISS.

35 Gneiss, Sherburne village.

QUARTZ ROCK.

36 Granular quartz, Mendon.
37 Quartz conglomerate, Mendon.
38 Talcose schist, Mendon.
39 Jointed quartz, South Pittsford.

EOLIAN LIMESTONES.

40 White marble, south quarry, Sutherland's Falls.
41 Mourning marble, south quarry, Sutherland's Falls.

42 Birds eye marble, south quarry, Sutherland's Falls.
43 Trap, calcareous (dike), Sutherland's Falls.
44 Porphyry (dike), Sutherland's Falls.
45 Impure limestone, adjoining Nos. 43, 44.
46 Marble (altered), adjoining Nos. 43, 44.
47 Lithographic marble, Sutherland's Falls.
48 Silicious limestone, near Sutherland's Falls.

TALCOID SCHISTS.

49 Talcoid schist, West Rutland.
50 Clay slate, West Rutland.
51 Contorted clay slate, West Rutland.
52 Contorted plumbaginous shales, West Rutland.

EOLIAN LIMESTONES.

53 Gray limestone, West Rutland.
54 Bluish limestone, West Rutland.
55 Marble, N.W. Rutland.
56 Italian blue marble, Sheldon & Slason's, West Rutland.
57 Blue marble, Sheldon & Slason's, W. Rutland.
58 White marble, Sheldon & Slason's, West Rutland.
59 Marble, upper white layer, Sheldon & Slason's, West Rutland.
60 Limestone over Hyde's quarry, West Rutland.
61 White marble, Hyde's, West Rutland.
62 Green marble, Hyde's, West Rutland.
63 Greenish marble, Barnes' south quarry, West Rutland.
64 White marble, Barnes' south quarry, West Rutland.
65 Blue marble, Barns' south quarry, West Rutland.

TALCOID SCHIST.

66 Black clay slate, West Rutland.
67 Talcoid schist, West Rutland.
68 Talcoid schist, south side of gorge, West Rutland.
69 Talcoid schist, Ira.
70 Quartz (vein), Ira.
71 Blackish limestone, with encrinites, Ira.
72 Clay slate, Ira.
73 Quartz and slate, Irâ.
74 Soft talcose schist, Ira.
75 Talcose conglomerate, Bird Mountain, Ira.
76 Talcose conglomerate, Bird Mountain, Ira.

GEORGIA GROUP.

77 Green clay slate, Castleton.
78 Decomposing quartz (vein), Castleton.
79 Green clay slate, Castleton.
80 Sparry limestone, West Castleton.
81 Clay slate, West Castleton.
82 Quartz (stratum), Allen's quarry, Fairhaven.
83 Green clay slate, Fairhaven.
84 Clay slate, with vein of limestone, Fairhaven.
85 Chocolate clay slate, Fairhaven.
86 Sparry limestone, Williams' quarry, Fairhaven.
87 Sparry limestone, Williams' quarry, Fairhaven.
88 Sparry limestone (at base of roofing slate), Fairhaven.
89 Quartz sandstone, with crystals of quartz (below the roofing slate), Fairhaven.
90 Brecciated limestone, Fairhaven.
91 Sparry limestone, Myers & Utter's, Fairhaven.
92 Roofing slate, Myers & Utter's Fairhaven.
93 Roofing slate, Hydeville.
94 Quartz and slate, Hydeville.
95 Talcose schist (bed), Hydeville.
96 Jointed alluvial clay, Fairhaven.
97 Jointed alluvial clay, Fairhaven.

TALCOID SCHIST

98 Talcoid schist, Fairhaven.
99 Talcoid schist, Fairhaven.

HUDSON RIVER GROUP.

100 Clay slate, West Haven.
101 Clay slate, West Haven.
102 Sparry limestone (east part), West Haven.
103 Sparry limestone (east part), West Haven.
104 Clay slate, West Haven.
105 Clay slate, West Haven.

TRENTON LIMESTONE.

106 Black compact limestone, West Haven.
107 Birds eye limestone, West Haven.

ALLUVIUM.

108 Consolidated gravel, West Haven.
109 Consolidated gravel, West Haven.
110 Consolidated gravel, West Haven.

CALCIFEROUS SANDROCK.

111 Calciferous sandrock, with fossil, West Haven.
112 Calciferous sandrock, West Haven.
113 Conglomerate of limestone fragments, Whitehall, N. Y.
114 Black gritty limestone, West Haven.
115 Calciferous sandrock, with red surface, Whitehall, N. Y.
116 Limestone, with black calcite, Whitehall, N. Y.
117 Calciferous sandrock, Whitehall, N. Y.
118 Chert in limestone, West Haven.
119 Quartz sandstone, West Haven.
120 Limestone, with calcite, West Haven.

POTSDAM SANDSTONE.

121 Compact quartz sandstone, West Haven.
122 Granite with Labradorite (vein), West Haven.
123 Granite with Labradorite (vein), West Haven.
124 Quartz rock, West Haven.
125 Hornblende schist, West Haven.
126 Hornblende schist, West Haven.
127 Compact quartz, West Haven.
128 Compact quartz, West Haven.
129 Gneiss, West Haven.
130 Gneiss, West Haven.
131 Red gneiss, West Haven.
132 Fine quartz sandstone, Whitehall, N. Y.
133 Fine quartz sandstone, Whitehall, N. Y.

LAURENTIAN GNEISS.

134 Gneiss with Labradorite, West Haven.
135 Gneiss, West Haven.
136 Gneiss, West Haven.

SANDSTONES.

137 Potsdam sandstone, Chapman's, West Haven.
138 Calciferous sandrock, Chapman's, West Haven.
139 Calciferous sandrock, West Haven, northwest corner.

APPENDIX TO SECTION VI.

CALCIFEROUS SANDROCK.

140 Calciferous sandstone, Benson.
141 Brecciated limestone, Chipman's, Orwell.
142 Silicious limestone, N.W. Benson.
143 Limestone with ferruginous coating, Benson.
144 Black slaty limestone, Benson.
145 Black slaty limestone, Benson.
146 Black limestone, Orwell.
147 Limestone with fossils, Orwell.
148 Black limestone, Orwell.
149 Black compact limestone, Orwell.
150 Compact limestone, Orwell.

ALLUVIUM.

151 Compact calcareous tufa, Orwell.
152 Calcareous tufa, Orwell.
153 Tufaceous sandstone, Orwell.
154 Tufaceous conglomerate, Orwell.
155 Calcareous tufa, Orwell.
156 Calcareous tufa, Orwell.
157 Pebble of porphyry, Orwell.

HUDSON RIVER GROUP.

158 Roofing slate, Benson.
159 Sandstone, Benson.
160 Roofing slate, Benson.
161 Clay slate, Orwell.
162 Clay slate, Orwell.
163 Sparry limestone, Benson.
164 Clay slate, Whiting.

RED SANDROCK SERIES.

165 Sandstone, Benson.
166 Sandstone, Benson.
167 Red sandrock, Orwell.

MISCELLANEOUS.

168 Calcareous tufa, Quechee Springs, Hartford.
169 Potsdam sandstone, Malone, N. Y.
170 Stalactite, Sutherland's Falls, Rutland.
171 Stalactite, Sutherland's Falls, Rutland.
172 Stalactite, Sutherland's Falls, Rutland.
173 Sparry limestone, Sudbury.

SECTION VII.

This Section commences at Connecticut River, in Thetford, passes through Thetford, Strafford, Sharon, Royalton, Bethel, Rochester, Goshen, Brandon, Sudbury, Orwell and across Lake Champlain to the west shore of Lake George, in New York. It is represented in colors in Plate XVI.

Adjacent to Connecticut River are strata of coarse talcose schist dipping 80° E. On Jeduthan Taylor's land in this formation there is a bed of impure steatite. Clay slate is found next west of the talcose schist, — the village of Thetford is located upon it. The strike and dip of the cleavage planes of this rock (which appear in many cases to coincide with those of stratification), are N. 24 E°. and 80° E. The strata at the lead mine dip 35° E. They pass insensibly into mica schist. The galena and blende at the old mine in Thetford, are present only in small quantities. The gangue of ore has nearly the same strike as the strata, but a greater dip.

The first strata of the calciferous mica schist, seen in the western part of Thetford, are perpendicular, and run N. 10° E. The next dip 75° E., with the same strike. At the Copperas works in Strafford the dip at the surface is 50° E., but in the lower shaft it is 74° E., with the strike N. 10° E. The bed of pyrites is often 60 feet wide. The dip of the bed coincides essentially with that of the strata adjacent. Half a mile west of the copperas works, the mica schist has the strike N. 10° E., and the dip 70° E. Two miles west of South Strafford the strike is N. 20° E., and the dip 45° E. Beds of hornblende schist appear dipping to the east and then to the west 80°, with the strike N. 10° E.; so that we have here an anticlinal like that in Guilford and Brattleboro. At Sharon the dip is 40° W. Two miles west of Sharon the most common dip of the mica schist is 40° N.W. There is very little of the silicious limestone associated with the mica schist thus far, but at South Royalton it is abundant, and dips 48° N.W. West of South Royalton mica schist without limestone dips 42° N.E.—thus forming an anticlinal. At Royalton the mica schist dips 20° N.W. One mile further it dips 30° northerly. Half a mile east of Bethel the mica schist dips 60° E. Here then is a narrow belt of clay slate also dipping 60° East.

At Bethel commences the talcose schist formation. Near its eastern border there is a fine bed of steatite. One-fourth of a mile from Bethel the talcose schist dips 72° N. E.—Seven miles east of Rochester the rock is talco-micaceous, and dips 45° N.E. Half a mile further talcose schist dips 70° E. A quarter of a mile further the strata are perpendicular. Five miles from Rochester the rock is chlorite schist, dipping 70° E. On the town line, three miles from Bethel the dip is from 10°–40°W. At the first bed of steatite the talcose schist dips 30° W. At Williams' quarry of steatite the strata dip from 40° W. to perpendicular. A mile and three-fourths east of Rochester we come upon a band of talcose schist, standing upon its edge for a quarter of a mile. A mile northeast of Rochester village, we find beds of dark quartz rock, with the strike N. 50° W. and the dip of 45°E. These beds are also found at the village. Two miles west of the village the talcose schist runs N. 80° E., and dips 45° E. Small nodules of dolomite are found in the strata here. At West Rochester, with the same strike, the dip is 50° E. West of this village the strike is at first N. 15° E., and then is N. 30° E., and dips 50° E. Soon it dips 40° E. This brings us to the top of the Green Mountains, and gneiss succeeds to the talcose schist, underlying it. This is in the east part of the town of Goshen. The gneiss is a coarse rock, sometimes with large blotches of feldspar. Its average dip is 40° E.

The quartz rock appears next. The formation is composed of hyaline quartz, talcose schist and argillo-talcose schist, in the order of the Catalogue. The observed dips were 60° E., 60° E., 75° E. and 70° E., with the strike N. 5° E. Considerations are presented elsewhere to show that perhaps beds of limestone alternate with the quartz. The west side of the quartz is at Forestdale, near the celebrated deposits of the tertiary period.

At Selden's marble mill, in the east part of Brandon, Eolian limestone appears, with the strike N. 40° E., and the dip of 80° E. Talcky seams are common in it. Some of the limestone in the vicinity contains several per cent. of an ore of iron, which is consequently used for a flux in the melting of the iron obtained at the hematite bed. Near Brandon Center the limestone dips 50° E. The dip is smaller just west of the Frozen Well, and soon dips to the west. In this case the strike is N. 20° E., and the dip 20° W. Two miles west of Brandon the dip is 20° E. Next succeeds the strata continuing north from Selden's marble quarry, in Pittsford. Then we find a bed of clay slate three feet thick. The last strata of limestone seen, run N. 40° E., and dip 30° S.E. The order of the limestones west of the westerly dip is as follows:

1. Fossiliferous limestone.
2. White marble.
3. Pink marble.
4. Beds of coarse limestone with clay slate.
5. Ordinary whitish limestone.

The Georgia group of clay slates occupies the mountain range in Sudbury, crossed by the Section. The strike of the slates is N. 45° E., and the dip 50° S.E. The west side of the mountain consists of talcoid schist, dipping 38° E., 25° E. and 52° E.

Limestone appears east of Sudbury church, dipping 30° E., then 7° northerly. Slaty limestone, near the church, dips 23° N.E. The marble comes next, and has an easterly dip. Other dips are these: 30°W., 13° E., 35° E. and 50° E. (N. 20° E.)

The kinds of limestone may be arranged in order as follows:

1. Ordinary whitish limestone.
2. Beds of coarse limestone with clay slate.
3. Pink marble.
4. White marble.
5. Fossiliferous limestone.

It is worthy of notice that the varieties of limestone are the same upon both sides of the Georgia group, but that they stand in reverse order. This looks as if the different kinds were connected with one another beneath the slate, as an inverted synclinal axis.

Rather more than a mile west of the church in Sudbury, there is clay slate. Then there is a bed of limestone; and finally a wide strip of clay slate, terminating westerly at A. Young's house in Orwell. This dips 50° E., 0°, and 21° E. Next succeeds a black fossiliferous limestone, running N. 15° E., and dipping 36° E. The west part of this band is blue, with the strike N. 20° E., and the same dip. This is the ledge called by Professor Emmons the sparry limestone of the Taconic system. A variety of clay slate is found to the west of this limestone, with the same dip. None of the fossils obtained from these limestones in Orwell are characteristic of any group of strata. Those obtained in the southwest part of Sudbury have an upper Silurian aspect.

We next come upon a calciferous limestone at Orwell, dipping 5° E. We suppose it to be the same with a ledge of white limestone running N. 60° E., which we have referred to the upper part of the Hudson River group. On the first hill west of the village the thick bedded limestone dips about 7° E. The rocks next in order are black, slaty limestone (H. R. slate); compact limestone; black, slaty limestone (Utica slate); compact, thick-bedded sparry limestone; thick-bedded and shaly limestone, supposed to be Trenton limestone, dipping 31° E. Mount Independence is composed of calciferous sandrock, with perhaps 30 feet of Potsdam sandstone at its base. The dip of both is 6° N.E. The Laurentian gneiss on the west side of Lake Champlain dips easterly; and at Garfield's station, on the west side of Lake George, similar strata dip 25° S.W.

SPECIMENS ILLUSTRATING SECTION VII.

TALCOSE SCHIST.

1 Mica schist, Thetford.
2 Clay slate, Thetford ("mine"),
3 Gangue of vein of galena, Thetford ("mine")
4 Steatite, Thetford.
5 Steatite and bitter spar, Thetford.
6 Talcose schist, calcareous, Thetford.

CLAY SLATE.

7 Clay slate, Thetford Hill.
8 Roofing slate, Thetford.

CALCIFEROUS MICA SCHIST.

9 Mica schist, Thetford.
10 Talco-micaceous schist, Thetford.
11 Talco-micaceous schist, Thetford.
12 Mica schist, Strafford.

13 Copper and Iron pyrites, Copperas Hill, Strafford.
14 Bog iron ore (gossan), Copperas Hill.
15 Talco-micaceous schist (wall rock of gangue), Copperas Hill.
16 Gangue of Copperas ore, Copperas Hill.
17 Mica schist at the lower drift, Copperas Hill.
18 Granite (bowlder), Strafford.
19 Decomposing rock, Strafford.
20 Mica schist, Strafford.
21 Disintegrating silicious limestone, Strafford.
22 Quartz (vein), Sharon.
23 Silicious limestone, Sharon.
24 Hornblende schist (bed), Sharon.
25 Silicious limestone, Sharon.
26 Mica schist, Sharon.
27 Mica schist, Sharon.
28 Concretionary mica schist, Sharon.
29 Mica schist, Sharon.
30 Granular quartz (stratum), Royalton.
31 Mica schist, Royalton.
32 Silicious limestone, Royalton.
33 Silicious limestone, South Royalton.
34 Garnets in hornblende schist, South Royalton.

CLAY SLATE.

35 Argillo-micaceous schist, Royalton.
36 Argillo-micaceous schist, Royalton.
37 Argillo-micaceous schist, Royalton.
38 Clay slate, Bethel.
39 Silicious limestone, Bethel.
40 Clay slate, Bethel.

TALCOSE SCHIST.

41 Talcose schist, Bethel.
42 Whitish talcose schist, Bethel.
43 Green steatite, Bethel.
44 Steatite, Bethel.
45 Iron ore, Bethel.
46 Iron ore, Bethel.
47 White granular dolomite, Bethel.
48 Talcose schist and dolomite, Bethel.
49 Talcose schist and dolomite, Bethel.
50 Talcose schist and dolomite, Bethel.
51 Talcose schist, Bethel.
52 Chlorite schist, Bethel.
53 Contorted talcose schist, Bethel.
54 Octahedral iron, Rochester.
55 Serpentine, "Iron Hill," Rochester.
56 Talc, cap of steatite, "Iron hill," Rochester.
57 Steatite, east bed, Rochester.
58 Green talc, east bed, Rochester.
59 Steatite, east bed, Rochester.
60 Talcose schist, Rochester.
61 Steatite calcareous, middle bed, Rochester.
62 Steatite, middle bed, Rochester.
63 Steatite, middle bed, Rochester.
64 Talco-micaceous schist, Rochester.
65 Talcose schist, Rochester.
66 Impure limestone with steatite, west bed, Rochester.
67 Chlorite with brown spar, west bed, Rochester.
68 Green steatite, west bed, Rochester.
69 Steatite, west bed, Rochester.
70 Green steatite, west bed, Rochester.
71 Serpentine and steatite, cap of west bed, Rochester.

SECTION FROM ADIT OF ROCHESTER SOAPSTONE QUARRY.

72 Talcose schist, Rochester.
73 Black talcose schist, Rochester.
74 Talcose schist, Rochester.
75 Talcose schist, Rochester.
76 Plumbaginous shale, Rochester.
77 Talcose schist, Rochester.
78 Black schist with pyrites, Rochester.
79 Weathered talcose schist, Rochester.
80 Clay slate, Rochester.
81 Clay slate, Rochester.

WEST OF THE ADIT.

82 Talcose schist, Rochester.
83 Quartz rock, Rochester village.
84 Talcose schist, Rochester village.
85 Talcose schist, Rochester.
86 Chlorite and pink dolomite, Rochester.
87 Talcose schist and dolomite, Rochester.
88 Green talcose schist, Rochester.
89 Talcose schist, West Rochester village.
90 Talcose schist, West Rochester.
91 Talcose schist, West Rochester.

GNEISS.

92 Gneiss, Goshen.
93 Gneiss, Goshen.
94 Gneiss, Goshen.

QUARTZ ROCK.

95 Hyaline quartz, Goshen.
96 Talcose schist, Goshen.
97 Talcose schist, Brandon.
98 Talcose schist, Brandon.
99 Gritty talcose schist (sandstone ?), Brandon.
100 Argillo-talcose schist, Brandon.
101 Argillo-talcose schist, Brandon.
102 Quartz with decomposing mineral, Brandon.
103 Argillo-talcose schist, Brandon.
104 Talcose schist, Brandon.
105 Argillo-talcose schist, Brandon.

EOLIAN LIMESTONES.

106 Silicious limestone with iron ore, Brandon.
107 Silicious limestone with iron ore, Brandon.
108 Dolomite colored by iron underlying the hematites, Forestdale.
109 Lignite with fruit and angular fragments of hyaline quartz (tertiary), Forestdale.
110 Dead ore (yellow), Forestdale.
111 Dead ore (red), Forestdale.
112 White Kaolin (tertiary), Forestdale.
113 White Kaolin (tertiary), Forestdale.
114 Umber (tertiary), Forestdale.
115 White limestone, Brandon.
116 Talcose schist (stratum), Brandon.
117 White limestone, Brandon.
118 Granular limestone, Brandon.
119 Talcky limestone, Brandon.
120 Talcky limestone, Selden's mill, Brandon.
121 Sparry limestone, Austin's quarry, Brandon.
122 White marble, Austin's quarry, Brandon.
123 Blue marble, Austin's quarry, Brandon.
124 Limestone, Austin's quarry, Brandon.
125 Black slaty limestone, Brandon.
126 Gray fossiliferous limestone, Brandon.
127 Compact gray limestone, Brandon.
128 Silicious limestone and slate, Brandon.
129 Fossiliferous limestone, Brandon.
130 Gray compact limestone, Brandon.
131 Gray slaty limestone, Brandon.
132 Thick-bedded sparry limestone, Brandon.
133 Blue marble, Selden's quarry, Brandon.
134 White marble, Selden's quarry, Brandon.
135 Impure slaty limestone, Sudbury.

GEORGIA GROUP.

136 Clay slate, Sudbury.
137 Clay slate, Sudbury.

EOLIAN LIMESTONE.

138 Sparry limestone, Sudbury.
139 Winooski limestone, Sudbury.
140 Pink marble, Sudbury.
141 Pink marble, Sudbury.
142 White marble, Sudbury.
143 White marble, Sudbury.
144 Fossiliferous limestone, Sudbury.
145 Encrinites and corals, Sudbury.
146 Contorted black slaty limestone, Sudbury.
147 Contorted black slaty limestone, Sudbury.
148 Grayish compact limestone, Sudbury.
149 Black argillaceous limestone, Sudbury.

HUDSON RIVER GROUP.

150 Clay slate, Sudbury.
151 Dove-colored limestone, Sudbury.
152 Black slaty argillaceous limestone, Sudbury.
153 Sparry limestone, Orwell.
154 Ferruginous conglomerate (alluvial), Orwell.
155 Plumbaginous shale, Orwell.
156 Plumbaginous shale with pyrites, Orwell.
157 Plumbaginous shale with quartz, Orwell.
158 Clay slate, Orwell.
159 Clay slate, Orwell.
160 Clay slate, Orwell.

LOWER SILURIAN LIMESTONES.

161 Black compact limestone (Trenton), Orwell.
162 Fossil corals, etc. from No. 161.
163 Sparry limestone, Orwell.
164 Clay slate, Orwell.
165 Calciferous sand rock (?), Orwell village.
166 Gray compact limestone, Orwell.
167 Black slaty limestone, Orwell.
168 Sparry limestone, Orwell.
169 Clay slate, Orwell.
170 Compact sparry limestone, Orwell.
171 Sparry limestone, Orwell.
172 Black slaty limestone, Orwell.
173 Black slaty limestone, Orwell.

CALCIFEROUS SANDROCK.

174 Compact limestone, Orwell.
175 Calciferous sandstone, Mount Independence.
176 Calciferous sandstone, Mount Independence.
177 Calciferous sandstone, Mount Independence.
178 Calciferous sandstone, Ticonderoga, New York.
179 Calciferous sandstone, Ticonderoga, New York.
180 Calciferous sandstone, Ticonderoga, New York.
181 Calciferous sandstone, Ticonderoga, New York.

POTSDAM SANDSTONE.

182 Quartz sandstone, Mount Independence.
183 Quartz sandstone, Mount Independence.

LAURENTIAN GNEISS.

184 Gneiss, Mount Defiance, New York.
185 Gneiss, Garfield's, Lake George.
186 Gneiss, Garfield's, Lake George.

APPENDIX TO SECTION VII.

187 Blue clay, Shoreham.
188 Brown clay, Shoreham.

POTSDAM SANDSTONE.

189 Quartz sandstone, Shoreham.
190 Quartz sandstone, Shoreham.

CALCIFEROUS SANDROCK.

191 *Maclurea matutina*, Newell's Mills, Shoreham.
192 *Maclurea matutina*, Newell's Mills, Shoreham.
193 Limestone with an argillaceous seam, Newell's Mills, Shoreham.
194 Clay slate, Shoreham.
195 Clay slate, Shoreham.
196 Black slaty limestone, Shoreham.
197 Calciferous sandstone, Salisbury.
198 Calciferous sandrock, Shoreham.

MISCELLANEOUS SPECIMENS.

199 Black marble (Chazy), Shoreham.
200 Black limestone, Shoreham, one-fourth mile west of village.
201 Utica slate, near Shoreham village.
202 Hudson River slate, near Shoreham village.
203 Red limerock, Whiting.
204 Pink marble, Whiting.
205 Pink marble, Whiting,
206 Variegated marble, Whiting.
207 Variegated marble, Whiting.
208 Variegated marble, Whiting.
209 Bluish marble, Whiting.
210 Bluish marble, Whiting.
211 Bluish marble, Whiting.
212 Bluish marble, Whiting.
213 Bluish marble, Whiting.
214 Gray marble, Whiting.
215 Bluish marble (Powers), Pittsford.
216 Marl with shells, Pittsford.
217 Marl, Pittsford.

218 Kaolin, Randolph Center.
219 Mica schist, Copper mine, Vershire.
220 Gangue, Copper mine, Vershire.
221 Indurated talcose schist, East Fairlee.
222 Gneiss, East Fairlee.
223 Gneiss, East Fairlee.
224 Gneiss, East Fairlee.
225 Gneiss with talc, East Fairlee.
226 Protogine, East Fairlee.
227 Indurated talcose schist, East Fairlee.
228 Clay slate, Ormsby & McLane, Fairlee.
229 Clay slate, Ormsby & McLane, Fairlee.
230 Talcose schist, Bradford.
231 Talcose schist, South Newbury.
232 Concretion, Sharon.
233 Concretion, Sharon.
234 Concretion, Sharon.
235 Concretion, Sharon.
236 Concretion, Sharon.
237 Drift striæ on marble, Sudbury.

SECTION VIII.

This section commences on the Connecticut River at Newbury, passes through Corinth, Washington, Williamstown, Brookfield, Roxbury, Granville, Ripton, Middlebury, Cornwall, and terminates at Lake Champlain, in Bridport. It is illustrated by colors in Plate XVI.

The talcose schist along Connecticut River is like that at the commencement of the two previous Sections. And the dip is also nearly perpendicular, leaning to the west. Part of the group consists of indurated and brecciated talcose schists. The bed of clay slate following is quite narrow. It was noticed only at Unionville, with the strike N. 20° E., and the dip of 65° E.

The calciferous mica schist commences in the west part of Newbury and extends to East Roxbury. It forms one great anticlinal; and the dip is considerably less midway between the anticlinal line and the two borders, than it is either near the line or the borders. A bed of pyrites is found in this rock at Corinth. In East Roxbury clay slate appears with a high westerly dip.

The talcose schist is very wide upon this section, and seems to form one great synclinal basin. Two or three beds of serpentine and steatite are found upon it in Roxbury and Warren. There are also plumbaginous shales upon it. The gneiss of the Green Mountains is probably an inverted anticlinal. The dips are 45° E., 70°W., 75° E., 69° E., and 34° E.

The quartz rock is composed of ten bands of different rocks, viz: hyaline quartz, compact sandstone, talcose and chlorite schists. They all dip east, alternating with one another, except the most western (quartz rock), which form an anticlinal, the east side dipping 50° E., and the west only 10° W. It apparently dips beneath the Eolian limestone of Middlebury, contrary to the general order of these two rocks.

The Eolian limestone, upon the route of this Section, seems to form a synclinal basin, resting upon the quartz rock, and the red sandrock series — as if the latter were the same rock. The following are the observations from which we have inferred this position:— At East Middlebury, N. 20° E., 36°W.; 10° W. to horizontal; 50° E. (north of Colleges); 28° N.E., in Cornwall, and 25° E. The rocks referred to the red sandrock series dip east about 20°. They are mostly gray calcareous grit rocks. They are succeeded on the west by the Hudson River group, both limestone and slate — the Utica slate, and the Trenton limestone. An anticlinal axis in the latter displays the Utica slate a second time, on the bank of Lake Champlain, in Bridport.

SPECIMENS ILLUSTRATING SECTION VIII.

TALCOSE SCHIST.

1 Talcose schist, Newbury.
2 Novaculite schist, Newbury.
3 Plicated talcose schist, Newbury.
4 Brecciated talcose schist, Newbury.
5 Bent talcose schist, Newbury.
6 Bent talcose schist, Newbury.
7 Concretionary trap (dike), Newbury.
8 Nodular granite (bowlder), Newbury.

CALCIFEROUS MICA SCHIST.

9 Hornblende, Newbury.
10 Hornblende, Newbury.
11 Argillo-micaceous schist, Newbury.
12 Copper pyrites, East Corinth.
13 Micaceous limestone, Corinth.
14 Mica schist, copper mine, Corinth.
15 Copper pyrites, copper mine, Corinth.
16 Silicious limestone, Corinth.
17 Greenstone (dike), Orange.
18 Silicious limestone, Orange.
19 Mica schist, Washington.
20 Silicious limestone, Washington.
21 Hyaline quartz (vein), Washington.
22 Mica schist, Washington.
23 Mica schist, Williamstown.
24 Peat, Williamstown.
25 Marl, Williamstown.
26 Muck and marl, Williamstown.
27 Marl, Williamstown.
28 Calcareous tufa, gulf spring, Williamstown.
29 Clay slate, Brookfield.
30 Silicious limestone, East Roxbury.

TALCOSE SCHIST.

31 Talcose schist, Roxbury.
32 Talcose schist, Roxbury.
33 Verd-antique serpentine, Roxbury.
34 Verd-antique serpentine, Roxbury.
35 Verd-antique serpentine, Roxbury.
36 Steatite, Roxbury.
37 Steatite, Roxbury.
38 Bog iron ore, Warren.
39 Bog iron ore, Warren.
40 Trap (dike), Warren.
41 Trap, concretionary, Warren.
42 Impure steatite, Warren.
43 Serpentine, burnt for lime! Warren.
44 Blue limestone, Granville.
45 White limestone, Granville.
46 Limestone, etc., Granville.
47 Granular limestone, Granville.
48 Talcose schist, Granville.
49 Gneiss, Granville.
50 Talcose schist, gold rock, Granville.
51 Talcose schist, Hancock.
52 Talcose schist with limestone, Hancock.
53 Plumbaginous shales, Hancock.
54 Irised plumbaginous shales, Hancock.

GNEISS.

55 Gneiss, Flint's tavern, Hancock.
56 Gneiss, Ripton.
57 Gneiss, Ripton.
58 Gneiss, Ripton village.

QUARTZ ROCK.

59 Hyaline quartz, Ripton.
60 Compact sandstone, Ripton.
61 Compact quartz, Ripton.
62 Talcose schist, Ripton.
63 Chlorite schist, Ripton.
64 Talcose schist, Ripton.
65 Talcose schist, Ripton.
66 Granular quartz, East Middlebury.

EOLIAN LIMESTONES.

67 Silicious limestone, East Middlebury.
68 Grayish limestone, Middlebury.
69 White marble, Middlebury.
70 Clouded marble, Middlebury.
71 Marble, Middlebury.
72 White marble, north quarry, Middlebury.

73 Flesh-colored marble, north quarry, Middlebury.
74 Gray compact limestone, Middlebury.
75 Gray compact limestone, Middlebury.
76 Green magnesian limestone, Middlebury.
77 Seams of slate in magnesian limestone, Middlebury.
78 Hyaline quartz in limestone, Middlebury.
79 Silicious limestone, N.W. Middlebury.
80 Dark silicious limestone, N.W. Middlebury.
81 Black slaty limestone, Cornwall.
82 Black slaty limestone, Cornwall.
83 Black sparry limestone, Shoreham.

UTICA AND HUDSON RIVER SLATES.

84 Utica slate, Shoreham.
85 Hudson River limestone, with *euomphalus*, Bridport.
86 Hudson River limestone, Shoreham.
87 Hudson River clay slate, Bridport.
88 Decomposing Utica slate, Shoreham.
89 Utica slate, Shoreham.
90 *Graptolithus bicornis* (Hall), above Frost's landing, Bridport.
91 Utica slate, Shoreham.

TRENTON LIMESTONE.

92 Trenton limestone, one-fourth mile north of Bridport Center.
93 *Lingula*, Frost's landing, Bridport.

APPENDIX TO SECTION VIII.

SNAKE MOUNTAIN SECTION.

94 Calciferous sandrock, Addison.
95 Calciferous sandrock, Addison.
96 Chazy limestone, Addison.
97 *Maclurea magna* (Hall), Addison.
98 Chazy limestone with encrinites, Addison.
99 Trenton limestone, Addison.
100 Trenton limestone, Addison.
101 *Chætetes lycoperdon*, Addison.
102 Slaty Trenton limestone, Addison.
103 Utica slate, Addison.
104 Utica slate, Addison.
105 Utica slate, Addison.
106 Hudson River slate, Addison.
107 Black compact limestone, Addison.
108 Sparry limestone, Addison.
109 Hudson River slate, Addison.
110 Jointed clay slate, Addison.
111 Sparry limestone, Addison.
112 Sparry limestone, Addison.
113 Sparry limestone, Addison.
114 Fossil from the limestone, Addison.
115 Silicious limestone, Addison.
116 Red sandstone, Weybridge.
117 Red sandstone, Weybridge.
118 Red sandstone, Weybridge.

SECTION FROM BRISTOL TO LINCOLN.

119 Quartz rock, upper bridge, Bristol.
120 Quartz rock, upper bridge, Bristol.
121 Quartz rock with fossils (?), Bristol.
122 Quartz rock, Bristol.
123 Quartz grit, Bristol.
124 Talcose schist, Bristol.
125 Talco-argillaceous schist, Lincoln.
126 Jointed talco-argillaceous schist, Lincoln.
127 Talcose schist, Lincoln.
128 Sandstone, Lincoln.
129 Talcose conglomerate, Union Store, Lincoln.
130 Talcose sandstone, Lincoln.
131 Talcose schist, interstratified with No. 132.
132 Mica schist, Lincoln.
133 Talcose schist, Lincoln.

LAURENTIAN GNEISS, Etc.

134 Gneiss, Fort Henry, New York.
135 Limestone, Fort Henry, New York.
136 Gangue of iron vein, Fort Henry, New York.
137 Gangue of iron vein, Fort Henry, New York.

138 Gangue of iron vein, Fort Henry, New York.
139 Gneiss, Fort Henry, New York.
140 Potsdam sandstone, Fort Henry, New York.

CALCIFEROUS SANDROCK.

141 Calciferous sandstone, Fort Henry, New York.
142 Calciferous sandstone, Fort Henry, New York.
143 Calciferous sandstone, Crown Pt., New York.
144 Calciferous sandstone, Panton.

CHAZY LIMESTONE, Etc.

145 Concretionary limestone, West Panton.
146 Concretionary limestone, West Panton.
147 Concretionary limestone, West Panton.
148 Concretionary limestone, West Panton.
149 Concretionary limestone, West Panton.
150 Limestone with corals, N.W. Ferrisburgh.
151 Limestone with chert, N.W. Ferrisburgh.
152 Chazy limestone, two miles west of Vergennes, Ferrisburgh.
153 Black limestone, N.W. Ferrisburgh.
154 Limestone (Chazy), one-half mile north of Ferrisburgh Center.
155 Chert in Chazy limestone, Ferrisburgh.
156 Birds eye limestone, Ferrisburgh.
157 Birds eye limestone, Crown Point, New York.
158 Utica slate, N.W. Panton.
159 Utica slate with graptolite, N.W. Panton.
160 Utica slate, North Ferrisburgh.
161 Utica slate, North Ferrisburgh.
162 Porphyry (dike), North Ferrisburgh.
163 Porphyry (dike), North Ferrisburgh.
164 Trachyte (dike), North Ferrisburgh.
165 Silicious limestone, New Haven.
166 Silicious limestone (H. R.), Ferrisburgh.
167 Black slaty limestone, New Haven.
168 Black slaty limestone, Weybridge.
169 Silicious limestone (H. R.), Ferrisburgh.
170 White marble, Seeley's quarry, Middlebury.
171 Coralline (?) white marble, Seeley's, Middlebury.
172 Blue coralline (?), marble, Seeley's, Middlebury.
173 Calcareous tufa, Monkton.

RED SANDROCK SERIES.

174 Brecciated sandrock, Monkton.
175 Brecciated sandrock, Monkton.
176 Brecciated sandrock, Monkton.
177 Novaculite schist, Monkton.
178 Novaculite schist, Monkton.
179 Calcareous sandstone, oven, Monkton.
180 Quartzose schist, New Haven.
181 Gray sandstone, Monkton.
182 Gray sandstone, Monkton.
183 Compact quartz sandstone, New Haven.
184 Compact quartz sandstone, New Haven.
185 Novaculite slate, New Haven.
186 Quartz sandstone, oven, Monkton.
187 Hyaline quartz, Monkton kaolin bed.
188 Porphyry (dike), Monkton.
189 Trap (dike), Waltham.
190 Decomposing sandstone, kaolin bed, Monkton.
191 White kaolin, Monkton.

MISCELLANEOUS SPECIMENS.

192 Talcose schist adjoining serpentine, Roxbury.
193 Talcose schist adjoining serpentine, Roxbury.
194 Serpentine, Warren.
195 Granite with blue quartz, Ripton.
196 Quartz sandstone (Potsdam), East Middlebury.
197 Talc, Waitsfield.
198 Black steatite, Waitsfield.
199 Steatite, Waitsfield.
200 Decomposing soapstone, Waitsfield.
201 Talcose schist, Waitsfield.
202 Black soapstone, Waitsfield.
203 Trap (dike), Waitsfield,
204 Soapstone, Waitsfield.
205 Ferruginous schist (source of ochre), Waitsfield.
206 Red kaolin, Waitsfield.
207 Bog iron ore, Waitsfield.
208 Yellow ochre, Waitsfield.
209 Claystone concretions, New Haven.
210 Claystone concretions, New Haven.
211 Dove-colored limestone, Middlebury.
212 Drift striæ, Vergennes, P. C. Tucker, donor.
213 Drift striæ, Vergennes, P. C. Tucker, donor.
214 Limestone, polished by drift, Vergennes, P. C. Tucker, donor.

SECTION IX.

This Section commences on Connecticut River, at Newbury, passes through Newbury, Topsham, Orange, Barre, Berlin, Montpelier, Middlesex, Waterbury, Bolton, Richmond, Jericho, Essex, Burlington, Colchester, and terminates at Valcour Island, in the west part of Lake Champlain. It is represented with colors on Plate XVI. Unlike all the other Sections, its course is northwesterly and southeasterly, therefore not crossing the strata at right angles to their course. It crosses Section X, in Middlesex. The first two rocks crossed over, vary but little from those described under Section VIII, viz: talcose schist and clay slate. The former stands nearly upon its edges with the strike N. 10° E., and the latter dips 78° E. In the west part of the town commences the calciferous mica schist, with a strike of N. 15° E., and an average dip of 75° E. All of this formation east of the great mass of granite in Orange dips east. At Richardson's mills, on the west side of the granite in Barre, the mica schist runs N. 30° E., and dips 85°W. The dip of all the rest of the mica schist is westerly.

A range of clay slate about two miles wide crosses the section next. Its western limit is at the Catholic church in Montpelier. The average strike of the formation is N. 25° E., and the dip about 75° W.

Next we come upon the talcose schist. The following is the succession of the different varieties:

At Catholic church in Montpelier, talcose schist, dip 67° W., strike N. 35° E. No. 36.
Coarse-grained talcose schist, north of the State House, N.E. and S.W., 72° N.W. No. 38.
Fine-grained talcose schist, with pyrites.
Compact green talcose schist. No. 46.
Gritty talcose schist. No. 41.
Talcose conglomerate. No. 42.
Soft talcose schist. No. 43.
Talcose conglomerate. No. 44.
Decomposing talcose sandstone. No. 48.
Compact talcose schist, altered sandstone. No. 49.
Gritty talcose schist. No. 50.
Talcose schist. No. 52.
Compact talcose conglomerate. No. 54.
Talcose schist. No. 55.
Talcose grit. No. 61.
Talcose schist. No. 62.
Compact talcose schist. No. 63.
Talco-argillaceous slate. No. 64.
Talcose schist. No. 65.
Talcose grit. No. 66.
Talcose schist. No. 67.
Bright-green talcose schist, at a railroad crossing in east part of Middlesex, dip 76° W.
Soft talcose schist. No. 71.
Shales. No. 72.
Soft talcose schist. No. 73.
Plumbaginous shales. No. 74.
Gritty talcose schist. No. 75.
Novaculite schist. No. 76.
Talcose sandstone. No. 78.
Novaculite schist. Nos. 79, 80, dip 67° W.
Clay slate. No. 84.
Talcose schist. No. 85.
Soft talcose schist, Middlesex Center. No. 86.
Soft talcose schist, weathering white.
Talcose schist (altered sandstone), strata perpendicular, Moretown.
Talcose schist.
Talcose schist containing dolomite.
Serpentine and steatite, Moretown.
Talcose sandstone.
Talcose schist, N. 17° E., 90°. Waterbury.

At Waterbury, gneissoid rocks and gneiss succeed to the talcose schist. They form the body of the Green Mountain range, which is cut through by the valley of Winooski River. This belt has the structure of an anticlinal axis, and the dip upon the west side is much steeper than that upon the east side. In the west part of Bolton the talcose schist re-appears, and extends into the west part of Richmond, forming a great synclinal basin, like its congener on the east side of the gneiss. The strata have a higher dip on the eastern side of the basin. The easterly dip commences at a short distance west of Jonesville. The varieties of rock in this belt are these: talcose schists and grits, the same with a little limestone, hornblende schist, gneissoid rocks, novaculite schist and clay slate. At the west side of the belt the dip is 55° E.

The section crosses next a talcose conglomerate, a formation described in Part II. It is made up of talcose schists, both very coarse, and fine talcose conglomerate, chlorite schist and clay slate. All the strata dip east, from 40° to 55°. At Painsville, we come upon a band of clay slate dipping about 40° E. It is succeeded on the west by Eolian limestone, having a very small easterly inclination of from 4° to 10°, except at its junction with the clay slate where there seems to have been a disturbance. The lower part of this limestone becomes silicious, and gradually passes into the gray and red sandstones of the red sandrock series. At Winooski Falls in Colchester is seen the first outcrop of the red sandstone. It has a small easterly dip. On the west, the so-called Winooski limestone takes its place at the base of the series. At Lonerock Point, the clay slates of the Hudson River group may be seen underlying the red sandrock series. This is underlaid by the Utica slate in the west part of Colchester. The Trenton limestone is to be found beyond, but it is covered mostly by the waters of Lake Champlain. The Chazy limestone appears upon Valcour Island, the western end of the section, with its characteristic fossils.

SPECIMENS ILLUSTRATING SECTION IX.

TALCOSE SCHIST.

1 Talcose schist with dendrite, Newbury.
2 Talcose schist with dendrite, Newbury.
3 Jointed talcose schist with dendrite, Newbury.
4 Calcareous talcose schist, Newbury.
5 Pink dolomite and quartz (vein), Newbury.
6 Talcose schist, Newbury.
7 Bent talcose schist, Newbury.
8 Bent talcose schist, Newbury.
9 Bent talcose schist, Newbury.
10 Talcose schist, Newbury.
11 Talcose schist, Newbury.
12 Talcose schist, Newbury.
13 Talcose schist, Newbury.
14 Talcose schist, Newbury.

CALCIFEROUS MICA SCHIST.

15 Clay slate, West Newbury.
16 Mica schist, Topsham.
17 Silicious limestone, Topsham.
18 Mica schist, Topsham.
19 Granite (bowlder), Topsham.
20 Silicious limestone, Topsham.

HORNBLENDE AND ADAMSITE SCHIST.

21 Hornblende and Adamsite slate, Topsham.
22 Decomposed silicious limestone, Topsham.
23 Mica schist, Orange.
24 Granite, Orange.
25 Granite, Orange.
26 Calcareous mica schist, Orange.
27 Whetstone mica schist, Barre.
28 Granite (State House quarry), Barre.
29 Hornblende schist, Barre.
30 Hornblende schist, Barre.
31 Mica schist, Barre.

CLAY SLATE.

32 Clay slate, Barre.
33 Clay slate, Barre.
34 Clay slate, Montpelier.
35 Clay slate, Montpelier.

TALCOSE SCHIST.

36 Talcose schist, Montpelier.
37 Talcose schist with iron pyrites, from a ledge directly under the State House.
38 Talcose schist, North of State House.
39 Talcose schist, North of State House.
40 Compact green talcose schist, Montpelier.
41 Gritty talcose schist, Montpelier.
42 Talcose conglomerate, Montpelier.
43 Talcose schist, Montpelier.
44 Talcose conglomerate, Montpelier.
45 Hyaline quartz (vein), Montpelier.
46 Talcose schist and quartz, Montpelier.
47 Quartz (stratum), Montpelier.
48 Decomposing talcose schist, Montpelier.
49 Compact talcose schist, Montpelier.
50 Talcose schist, Montpelier.
51 Contorted talcose grit, Montpelier.
52 Talcose schist, Montpelier.
53 Talcose schist, Montpelier.
54 Compact talcose conglomerate, Montpelier.
55 Talcose schist, Montpelier.
56 Carbonate of lime upon No. 55.
57 Calcite, with No. 55.
58 Calcite and quartz with No. 55.
59 Quartz and talcose schist, Montpelier.
60 Quartz and talcose schist, Montpelier.
61 Talcose grit, Montpelier.
62 Talcose schist, Middlesex.
63 Compact talcose schist, Middlesex.
64 Talco-argillaceous slate, Middlesex.
65 Talcose schist, Middlesex.
66 Talcose grit, Middlesex.
67 Talcose schist, Middlesex.
68 Talcose schist, Middlesex.
69 Talcose schist, Middlesex.
70 Talcose grit, Middlesex.
71 Novaculite schist, Middlesex.
72 Clay slate, Middlesex.
73 Talcose schist, Middlesex.
74 Plumbaginous shales, Middlesex.
75 Talcose grit, Middlesex.
76 Novaculite schist, Middlesex.
77 Gritty seams (sandstone ?), in talcose schist, Middlesex.
78 Talcose schist (sandstone), Middlesex.
79 Novaculite schist, Middlesex.
80 Novaculite schist, Middlesex.
81 Coarse grit, (sandstone stratum), Middlesex.
82 Novaculite schist, Middlesex.
83 Novaculite schist, Middlesex.
84 Clay slate, Middlesex.
85 Talcose schist, Middlesex.
86 Talcose schist with dolomite, Middlesex village.
87 Talcose schist (weathers white), Moretown.
88 Talcose schist (altered sandstone), Moretown.
89 Talcose schist (altered sandstone), Moretown.
90 Talcose schist, Moretown.
91 Talcose schist, Moretown.
92 Talcose schist with dolomite, Moretown.
93 Talcose schist with quartz, Waterbury.
94 Serpentine, Barnes', Waterbury.
95 Steatite, Pinneo's, Waterbury.

GNEISS AND GNEISSOID ROCKS.

96 Gneiss, Waterbury.
97 Gneiss, Falls, Waterbury.
98 Gneiss, Bolton.
99 Gneiss, Bolton.
100 Gneiss, Bolton.
101 Gneiss, Bolton.
102 Gneiss, Bolton.
103 Gneiss, Bolton.
104 Gneissoid rock, Bolton.
105 Gneiss, Bolton.

TALCOSE SCHIST.

106 Talcose schist with Adamsite, Bolton.
107 Talcose gneiss, Bolton.
108 Talcose schist, Bolton.
109 Gneissoid talcose schist, Bolton.
110 Talcose schist, Jonesville.
111 Quartz (stratum), Jonesville.

112 Talcose schist, Jonesville.
113 Talcose schist, Jonesville.
114 Talcose schist, Jonesville.
115 Talcose schist, Jonesville.
116 Hyaline quartz (vein), Jonesville.
117 Talcose schist with limestone, Jonesville.
118 Gneissoid rock, Richmond.
119 Talcose schist, Richmond.
120 Green hornblende schist, Richmond.
121 Green hornblende schist, Richmond.
122 Green hornblende schist, Richmond.
123 Quartz and calcite, Richmond.
124 Trap (dike), Richmond.
125 Jointed talcose schist, Richmond.
126 Talcose schist, Richmond.
127 Talcose schist, Richmond.
128 Novaculite schist, Richmond.
129 Clay slate, Richmond.

TALCOSE CONGLOMERATES.

130 Conglomerate, Richmond.
131 Granite pebbles from conglomerate, Richmond.
132 Conglomerate, Richmond.
133 Conglomerate, Richmond.
134 Quartz pebbles from conglomerate, Richmond.
135 Conglomerate, Richmond.
136 Conglomerate, Richmond.
137 Conglomerate, Richmond.
138 Talcose schist, Richmond.
139 Conglomerate, Richmond.
140 Conglomerate, Richmond.
141 Limestone from conglomerate, Richmond.
142 Talcose schist, Jericho.
143 Talcose schist, Jericho.
144 Quartz and feldspar, Jericho.
145 Quartz and feldspar, Jericho.
146 Talcose sandstone, Jericho.
147 Talcose schist, Jericho.
148 Contorted talcose schist, Jericho.
149 Talco-argillaceous slate, Jericho.
150 Talcose schist, Jericho.
151 Talcose schist (with sandstone), Jericho.
152 Chlorite schist and quartz, Jericho.
153 Chlorite and quartz, Jericho.
154 Talcose schist, Essex.
155 Conglomerate, Essex.
156 Talcose schist, Essex.

GEORGIA SLATE.

157 Clay slate, Williston.
158 Quartz and calcite, Essex.
159 Clay slate, Essex.
160 Clay slate, Essex.
161 Limestone from 160.
162 Limestone from 160.
163 Calcite from 160.
164 Amygdaloidal trap (dike), Essex.
165 Trap dike, Essex.

EOLIAN LIMESTONE.

166 Brecciated limestone, Essex Junction.
167 Calcareous sandstone, Williston.
168 Dark colored limestone, Williston.
169 Dove-colored limestone, Penniman's, Colchester.
170 Dove-colored limestone, Penniman's, Colchester.

RED SANDROCK SERIES.

171 Variegated limestone, Colchester.
172 Silicious limestone, Colchester.
173 Silicious limestone, Colchester.
174 Sparry limestone, Colchester.
175 Calcareous quartz, Colchester.
176 Limestone, Colchester.
177 Black slaty limestone, Burlington.
178 Black limestone, Burlington.
179 Light colored trap, Burlington.
180 Novaculite schist, Burlington.
181 Calcareous quartz rock, Winooski Falls.
182 Red sandstone (calcareous), Winooski Falls.
183 Red sandstone, Burlington.
184 Red sandstone, Burlington.
185 Rose-colored limestone, Burlington.
186 Striped sandstone, Burlington.
187 Red sandstone with fucoids, Burlington.
188 Black sandrock, Burlington.
189 Breccia bowlder, Burlington.
190 Red sandstone, Burlington.
191 Winooski limestone, Burlington.

HUDSON RIVER GROUP.

192 Black slate, Appletree Point, Burlington.
193 Black slate, Appletree Point, Burlington.
194 Black slaty limestone, Burlington.
195 Black (Utica) slate, Colchester Point.

APPENDIX TO SECTION IX.

196 Red sandstone, Colchester.
197 Winooski marble, Colchester.
198 Winooski marble, Colchester.
199 Dove-colored limestone, Bates', Colchester.
200 Dove-colored limestone, Bates', Colchester.
201 Dove-colored limestone, Bates', Colchester.
202 Sparry limestone, Mallett's Head, Colchester.
203 Alluvial conglomerate, Mallett's Head, Colchester.
204 Winooski limestone, Milton.
205 Utica slate, South Hero.

SECTION X.

This Section commences at Tuckerman's Ravine on the east side of Mount Washington in New Hampshire, and passes over Camel's Hump, in Vermont, terminating on Lake Champlain, at Charlotte. Thus it shows the mutual relations of the Green and White Mountain ranges to each other. It passes over the top of Mount Washington, down the Lower Amonoosuc River, through Bethlehem and Littleton to Connecticut River, whence it passes in Vermont through the towns of Waterford, Barnet, Peacham, Marshfield, North Montpelier, Middlesex, Corner of Moretown, Duxbury, Huntington, Hinesburgh and Charlotte. It is the longest of all the sections, and is represented by colors in Plate XVII.

The first rock on the Section is a coarse mica schist sometimes feldspathic. At Tuckerman's Ravine, on the east side of Mount Washington, about two thousand feet below the summit, this rock dips 28° westerly. On the top of the mountain the same rock appears dipping 25° northwesterly. At the half way house between the summit and the White Mountain House, the same rock appears, dipping 30° northerly. Thus there is an approximation to a synclinal axis in the structure of Mount Washington. J.P.Lesley, Esq., of Philadelphia, has also noticed the synclinal structure of this mountain. He regards the rock as altered Devonian strata.

Those who pass from the summit to the Crawford House, on the west side of the Mountain, find the rocks to be granite entirely, except at the summit. Our section passes north of the granite. Possibly the disturbing agency of the granite has produced the northerly inclination of so much of the strata.

Between the Half-way House and the west part of Littleton, no rocks were seen except granite, on the line of the Section. The rocks are generally concealed by drift. We saw ledges of granite at the Lower Falls of the Amonoosuc River, in Bethlehem and in Littleton.

In the west part of Littleton the granite is porphyritic. This is succeeded by nearly perpendicular strata of talcose schist. This formation seems to form a sharp synclinal axis. The strata at the west end dip 65° E. It is the Connecticut River range of talcose schist. The whole of the formation is exposed upon this Section. The details are given elsewhere.

Passing by a narrow belt of clay slate, we come upon the calciferous mica schist, in Barnet and Peacham. This dips east invariably. Between the villages of Peacham and Marshfield there is an immense display of granite. West of the granite the calciferous mica schist group is found as far as North Montpelier, and everywhere with a westerly dip. A narrow band of clay slate appears next, dipping west, followed by the great synclinal of talcose schist. The characters of this rock on this Section agree perfectly with those already described under Section IX. The crest of the anticlinal of Camel's Hump appears to lie east of the axis of the mountain range. The mountain was once higher than it is now, and its crest was at least a mile further east. As upon Section IX, the talcose schist and conglomerates appear west of the gneissoid rocks. The red sandrock series succeeding is made up of the following members:

Silicious limestone, N. 10° E., 22° E.
Silicious limestone, at Hinesburgh village, N. 20° E., 15° E.
Silicious limerock, almost quartz, N. 35° E., 25°W.
White limestone, near Hinesburgh, west line, 45° E.
Quartz rock on the town line, N. 10° E., 65°W.
Quartz rock, east of O. Hazard's house in Charlotte, 5° E.
Same rock at his house, 28° E.
East part of Charlotte, quartz rock, N. 9° E., 35°W.
Gray sandstone, at Mrs. L. A. Fuller's house, N. 20°W., 26° E.
A few rods distant, white (Eolian) limestone, 80° S.E.
Red sandstone, at J. A. Williams', N. 15°W., 16° E.
Gray sandstone, Mutton Hill, N. 20°W., 15° E.

Going west from Mutton Hill we find the Hudson River slate, dipping east. The Utica slate probably occupies the plain west of the village. Trenton limestone is in place at the west end of the Section at McNeil's Point. Chazy limestone is said to be in place between McNeil's Point and the village of Charlotte.

SPECIMENS ILLUSTRATING SECTION X.

MICA SCHIST AND GRANITE.

1 Mica schist with feldspar, Tuckerman's Ravine, Mount Washington, N. H.
2 Mica schist with feldspar, summit of Mount Washington, N. H.
3 Granite (vein), Mount Washington, N. H.
4 Nodules of granite in granite, Mt. Pleasant, N. H.
5 Granite, White Mountain notch, N. H.
6 Granite, lower falls of the Amonoosuc River, N. H.
7 Granite, Bethlehem, N. H.
8 Porphyritic granite, Littleton, N. H.

TALCOSE SCHIST.

9 Talcose schist, Littleton, N. H.
10 Indurated talcose schist, Littleton, N. H.
11 Talcose schist, Littleton, N. H.
12 Talcose schist, Waterford.
13 Porphyritic hornblende, Waterford.
14 Hornblende schist, Waterford.
15 Talcose schist, Waterford.
16 Talcose schist, Waterford.
17 Talcose schist, Barnet.
18 Brecciated syenite, Barnet.

CLAY SLATE.

19 Clay slate, Barnet.
20 Clay slate, Barnet.

CALCIFEROUS MICA SCHIST.

21 Mica schist, Stevens village, Barnet.
22 Silicious limestone, Stevens village, Barnet.
23 Hornblende, Barnet.
24 Silicious limestone, Barnet.
25 Argillo-micaceous slate, Barnet.
26 Argillo-micaceous slate, Barnet.
27 Granite (bowlder), Barnet.
28 Granite (bowlder), Barnet.
29 Soil, Peacham Corners.
30 Silicious limestone, Peacham Corners.
31 Quartz (vein), Peacham Corners.
32 Granite (vein), Peacham Corners.
33 Granite (thick vein), Peacham.
34 Granite (prevailing rock), Peacham.
35 Granite, Peacham.
36 Granite, Marshfield.
37 Coarse granite, Marshfield.
38 Gneiss (?) (thick bed), Marshfield Center.
39 Granite with vein of feldspar, Marshfield.
40 Granite, Marshfield.
41 Argillo-micaceous slate, Marshfield.
42 Mica schist, Marshfield.
43 Silicious limestone, Marshfield.
44 Argillo-micaceous slate, Marshfield.
45 Jointed mica schist, North Montpelier.
46 Silicious limestone, North Montpelier.
47 Hornblende schist, North Montpelier.
48 Silicious limestone, North Montpelier.
49 Hyaline quartz, North Montpelier.
50 Silicious limestone, North Montpelier.
51 Claystones, Montpelier.
52 Clay slate with fossil (?), Montpelier.

TALCOSE SCHIST.

53 Talcose schist, North Montpelier.
54 Talcose schist, Montpelier.
55 Talcose schist, Montpelier.
56 Talcose schist, Montpelier.
57 Novaculite schist, West Montpelier.
58 Hornblende schist, Middlesex.
59 Mica schist with garnets, Middlesex.
60 Novaculite schist, Middlesex.
61 Talcose grit, Middlesex.
62 Coarse grit, calcareous, Middlesex.
63 Talcose schist, Middlesex.
64 Talcose schist, same as $\frac{6}{3}$, Middlesex village.
65 Talcose schist, Moretown.
66 Talcose schist (altered sandstone), Moretown.
67 Talcose grit with dolomite, Moretown.
68 Hornblende schist, Moretown.
69 Hornblende rock, Moretown.
70 Talcose schist, Moretown.
71 Hornblende schist, Moretown.
72 Steatite, Moretown.
73 Steatite, Moretown.
74 Chlorite, Moretown.
75 Steatite, Moretown.
76 Chlorite, south bed, Moretown.
77 Serpentine, south bed, Moretown.
78 Serpentine, south bed, Moretown.
79 Hornblende rock, south bed, Moretown.
80 Slaty steatite, south bed, Moretown.
81 Steatite, south bed, Moretown.
82 Green steatite, (bottom rock), S. bed, Moretown.
83 Mica schist, Moretown.
84 Mica schist, Moretown.
85 Talcose schist with limestone, Moretown.
86 Dolomite (?), Moretown.
87 Dolomite, Moretown.
88 Talcose schist, Moretown.
89 Dolomite, Moretown.
90 Talcose schist, Duxbury, southeast part.
91 Talcose schist, Duxbury, southeast part.
92 Steatite, Duxbury, southeast part.
93 Steatite, Duxbury, southeast part.
94 Impure steatite, Duxbury, southeast part.
95 Calcite, etc., Duxbury, southeast part.
96 Porous quartz, etc., Duxbury, southeast part.
97 Talcose schist, Duxbury, southeast part.
98 Talcose schist, Duxbury, southeast part.
99 Talcose schist, Duxbury.

GNEISS AND GNEISSOID ROCKS.

100 Gneiss, east side of Camel's Hump.
101 Pebble of jaspery iron ore, Camel's Hump.
102 Gneissoid rock, Camel's Hump.
103 Talcose gneiss, top of Camel's Hump.
104 Gneiss, top of Camel's Hump.
105 Talcose gneiss, top of Camel's Hump.

TALCOSE SCHIST AND CONGLOMERATES.

106 Syenite, Huntington.
107 Quartz (stratum), Huntington.
108 Talcose schist, Huntington.
109 Talcose schist, Hinesburgh.
110 Talcose schist, Hinesburgh.

RED SANDROCK SERIES.

111 Silicious limestone, Hinesburgh.
112 Calcareous quartz, Hinesburgh.
113 Calcareous sandstone, Hinesburgh.
114 Sandstone (calcareous), Hinesburgh.
115 Limestone, Hinesburgh.
116 Quartzose limerock, Hinesburgh.
117 Quartz rock, East Charlotte.
118 Quartz rock, East Charlotte.
119 Porphyry (dike), East Charlotte.
120 Quartz rock, East Charlotte.
121 Quartz sandstone, East Charlotte.
122 Gray silicious limestone, East Charlotte.
123 Silicious limestone, East Charlotte.
124 Dove-colored limestone, East Charlotte.
125 Gray sandstone, Charlotte.
126 Red sandstone, Charlotte.
127 Sandstone and slate, Mutton Hill, Charlotte.
128 Novaculite schist, Mutton Hill, Charlotte.
129 Novaculite schist, Mutton Hill, Charlotte.
130 Novaculite schist, jointed, Mutton Hill, Charlotte.
131 Gray compact limestone, Charlotte.
132 Gray sandstone, hill south of Charlotte.

HUDSON RIVER GROUP.

133 Black slate, Mutton Hill, Charlotte.
134 Sparry limestone, Charlotte.
135 Sparry limestone, Charlotte.
136 Calcite and slate, Charlotte.
137 Calcite and slate, Charlotte.
138 Calcite and slate, Charlotte.

TRENTON LIMESTONE.

139 Labradorite (bowlder), Charlotte.
140 Labradorite (bowlder), Charlotte.
141 Granite (bowlder), Charlotte.
142 Trap dike, McNeil's Point, Charlotte.
143 Porphyry dike, McNeil's Point, Charlotte.
144 Trenton limestone with fossils, McNeil's Point, Charlotte.
145 Pebbles, McNeil's Point, Charlotte.

APPENDIX TO SECTION X.

146 Utica slate, Shelburne.
147 Utica slate, Shelburne.
148 Utica slate, Shelburne.
149 Jointed clay slate, Shelburne Point.
150 Utica slate, Shelburne Point.
151 Veins of calcite in Utica slate, Shelburne Pt.
152 Veins of calcite in Utica slate, Shelburne Pt.
153 Veins of calcite in Utica slate, Shelburne Pt.
154 Veins of calcite in Utica slate, Shelburne Pt.
155 Veins of calcite in Utica slate, Shelburne Pt.
156 Veins of calcite in Utica slate, Shelburne Pt.
157 Veins of calcite in Utica slate, Shelburne Pt.
158 Veins of calcite in Utica slate, Shelburne Point.
159 Silicious limestone, Shelburne.
160 Green clay slate, South Williston.
161 Utica slate, Rock Dunder.
162 Winooski limestone bowlder, Rock Dunder.
163 Granite (bowlder), Rock Dunder.
164 Gneiss (bowlder), Rock Dunder.
165 Utica slate limestone, Juniper Island.
166 Clay stone, Shelburne.
167 Clay stone, Shelburne.
168 Red sandstone, Shelburne.

DIKES FROM NASH'S POINT, SHELBURNE.

169 Trachytic porphyry. (A) (See Fig. 315.)
170 Trachytic trap amygdaloidal. (B)
171 Trachytic trap amygdaloidal. (B)
172 Trachytic porphyry. (B)

173 Trachytic trap. (B)
174 Breccia of Utica slate, red sandstone, granite, etc. (B)
175 Breccia of Utica slate, red sandrock, etc. (B)
176 Breccia of Utica slate, red sandrock, etc. (B)
177 Utica slate imbedded in trachytic trap. (B)
178 Breccia of Utica slate, etc., with trachytic trap. (B)
179 Breccia of Utica slate, etc., with trachytic trap. (B)
180 Breccia of Utica slate, etc., with trachytic trap. (B)
181 Trachytic trap. (C)
182 Trachytic trap. (D)
183 Trachytic trap. (D)
184 Trachytic trap. (E)
185 Trachytic trap. (E)
186 Trachytic trap. (F)
187 Utica slate from dike. F)
188 Utica slate underlying dike. (F)
189 Amygdaloidal trap. (G)
190 Amygdaloidal trap. (G)
191 Amygdaloidal trap. (G)
192 Porphyritic trap.
193 Porphyry, Shelburne.
194 Porphyry (bowlder), Shelburne.
195 Porphyry (bowlder), Shelburne.
196 Trap, Charlotte.
197 Trap, Charlotte.
198 Trachytic trap, Charlotte.

X*a*. SECTION FROM LUNENBURGH TO BURLINGTON.

TALCOSE SCHIST.

199 Talcose schist, Lunenburgh.
200 Talcose schist, Lunenburgh.
201 Trap, West Concord.
202 Trap, West Concord.
203 Mica schist, West Concord.
204 Trap (dike), Hale & Brackett's, Waterford.
205 Clay slate, Hale & Brackett's, Waterford.

CALCIFEROUS MICA SCHIST.

206 Mica schist, St. Johnsbury.
207 Veins of granite in silicious limestone, St. Johnsbury.
208 Silicious limestone, St. Johnsbury.
209 Mica schist with Adamsite, Cabot.
210 Silicious limestone, Lyndon.
211 Mica schist, Lyndon.
212 Silicious limestone, Lyndon.
213 Micaceous limestone, Wheelock.
214 Silicious limestone, Wheelock.
215 Mica schist with Adamsite, Wheelock.
216 Mica schist with Adamsite, Wheelock.
217 Mica schist with Adamsite, Wheelock.
218 Granite, Greensboro.
219 Mica schist, Greensboro.
220 Hornblende schist, Greensboro.
221 Silicious limestone, Greensboro.
222 Mica schist, Greensboro.
223 Silicious limestone, Hardwick.
224 Mica schist, Hardwick.
225 Silicious limestone, Hardwick Center.
226 Silicious limestone, South Hardwick.

CLAY SLATE.

227 Clay slate, South Hardwick.
228 Clay slate, South Hardwick.
229 Clay slate, South Hardwick.

TALCOSE SCHIST.

230 Talcose schist, Hardwick.
231 Talcose schist, Wolcott.
232 Quartzose schist, Wolcott.
233 Talcose schist, Wolcott.
234 Talcose schist, Wolcott.
235 Talcose schist, Eagle Ledge, Elmore.
236 Talco-micaceous schist, Wolcott.
237 Epidotic talcose schist, Wolcott.
238 Talcose schist, Wolcott.
239 Hornblende schist, Hydepark.
240 Hornblende schist, Morristown.
241 Novaculite schist, with chalybite and galena, Morristown.
242 Talcose schist and quartz, Hydepark.
243 Talcose schist, Johnson.

GNEISS AND GNEISSOID ROCKS.

244 Talcose schist, top of Mansfield Chin.
245 Talcose schist with magnetite, top of Mansfield Chin.
246 Gneiss, Mansfield Mountain, west side.
247 Talcose schist, Mansfield Mountain, west side.
248 Talcose schist, Underhill.
249 Talcose schist, Jericho Corners.

SECTION X*a*.

Nos. $\frac{10}{199}$ to $\frac{10}{249}$ illustrate the character of the rocks between Lunenburgh and Burlington. Owing to the scarcity of specimens collected upon its route, it was thought best not to rank it as a distinct Section, to be represented at the State Cabinet, but that the observations might be grouped together into a sub-section, illustrated in the Report (Plate XVII), while the specimens should be placed in the Appendix to Section X. The towns traversed by this Section are Lunenburgh, Concord, Waterford, St. Johnsbury, Danville, Walden, Hardwick, Morristown, Cambridge, Underhill, Jericho, Essex and Burlington. The rocks correspond so nearly with those upon the south Section that we need not describe them in detail. The most important feature of this Section is the showing of the anticlinal structure of Mansfield Mountain. The Section between Mansfield Mountain and Burlington is mostly based upon the very careful observations of Prof. Zadock Thompson.

SECTION XI.*

This Section passes through Guildhall, Granby, the north part of Victory, Burke, Sutton, Sheffield, Glover, North Greensboro, Craftsbury, Hydepark, Johnson, Cambridge, south parts of Fletcher, Fairfax and Georgia, the north-west corner of Milton, crosses the east part of Lake Champlain to North Hero, and terminates in one of the Sister's Islands—a total length of 90.8 miles. Upon both sides of Connecticut River, both in Guildhall and in Northumberland, N. H., there is a large amount of *protogine*, differing from granite only by the substitution of talc for mica. The rock very much resembles the gneiss of Kilburne Peak at the east end of Section IV, and has similar rocks associated with it. The likeness of the two rocks is strengthened by the similarity of their topography—both forming steep mountains, upon the east bank of the same river, while the interesting terraces at Guildhall reminds one forcibly of the complicated surface geology at Bellows Falls. It is not unlikely that the protogine in Guildhall may, after all, prove to be stratified. This question was not settled upon the ground; and certain seams resembling strata were found dipping 25° E. The talc is not so well characterized in this rock as we should have desired (Nos. $\frac{11}{1}$ to $\frac{11}{3}$.) It seems rather to correspond with the minerals, whatever they may be, that constitute the bulk of the so-called talcose schist, which generally contains no magnesia. This mineral, however, has been subjected to no chemical tests.

Passing west from Connecticut River, quite an extensive meadow is seen; and unlike meadows generally, this one is situated wholly upon the second terrace, an old bed of the river passing through it. Upon a branch of the Connecticut upon the road to Granby, seven terraces occur in succession above one another, all being very distinct.

*The Notes upon Section XI, are compiled from the observations of Rev. S. R. Hall and C. H. Hitchcock. The Notes upon Section XII. and XIII. are almost entirely those of Rev. S. R. Hall. They have been thrown into a form somewhat different from the original, that there might be a unity throughout the whole of Part V.

The protogine probably occupies the space east of the third terrace. West of it are numerous bowlders of tough hornblende rock, and several varieties of granite (Nos. $\frac{11}{4}$ to $\frac{11}{7}$.) The first rock seen is indurated mica schist, running N. 58° E., and dipping 74° W., (Nos. $\frac{11}{8}$, $\frac{11}{9}$.) Talcose schists (Nos. $\frac{11}{13}$, $\frac{11}{14}$), with seams of quartz rock (No. $\frac{11}{12}$), next appear standing upon their edges and running N. 45° E. Upon looking at the edges of these strata (No. $\frac{11}{13}$), they seem almost to contain pebbles, and are much like ledges of Winooski marble.

No. $\frac{11}{10}$ is granite from a bowlder. We were unable to visit that part of the town where it is found in place, having been hindered by heavy rains. In the northwest corner of the town there is a very compact dike, similar to one near West Bethel. As our former guide to it had left town, we were unable to find it. In that vicinity the magnetic needle is said to be so strongly attracted, by some local cause, as to be utterly useless for surveying.

The rock in Granby and Victory is mostly indurated mica schist, represented by a number of specimens. We will notice any unusual or remarkable specimens. No. $\frac{11}{15}$ is singularly contorted mica schist; occurring in huge bowlders in great abundance, but nowhere seen *in situ*. Acres of surface in Mr. Wells' pasture, near Granby church, are covered by them. No. $\frac{11}{17}$ is a remarkable specimen. It is granite, containing fragments of mica schist, apparently the same as the rock of the neighborhood, and of quartz rock. Many of the pebbles had evidently been rounded by water before they were placed in their present position in an igneous rock. This specimen was taken from a bowlder near the same place as the previous specimen: but no hand specimens can properly show the general size and shape of the pebbles, or the aspect of the rock. Specimens of such rocks have a most important bearing upon our theories respecting the origin of granite and other igneous rocks.

The minerals staurotide and chiastolite (macle) are very abundant in many ledges; so much so as to give character to the rock. Similar minerals constitute a large per cent. of the mica schist of Mount Washington, N. H. Two bands of talcose schist were seen in the midst of the mica schist: one in Granby, east of the village, running N. 40° E., and dipping 80° S.E. (No. $\frac{11}{28}$); and the other in the west part of Victory, dipping 50° S.E. The mica schist varied in position as follows: in the east part of Granby the strata dip 65°W. West of the talcose schist in Granby the strike is N. 55° E., and the dip 80° S.E.; the same position appearing in most of the ledges east of Granby village. About a mile north of Granby church, the dip is 80° S. and the direction N. 80° E. In Victory the mica schist is associated with quartz veins, is twisted much into small contortions and runs N. 60°W, dipping 55° S. E. The direction of numerous jointed seams in these strata is north and south, and their inclinations are 65° E. and 40° E. Near the west line of Victory the direction of the schist is N. 20° E., and its dip 45° E. Upon the height of land between Victory and Burke the strike is the same, but the dip is 40° E.

No. $\frac{11}{22}$ consists of quartz and the mineral called Adamsite in this Report. Perhaps then the rock ought to be called *Adamsite schist*, as it occurs in large masses here and elsewhere in the State. Other specimens of the same schist are enumerated upon the Catalogue.

Nos. $\frac{11}{25}$ and $\frac{11}{26}$ are gneissoid conglomerate. The paste is granitic, and the rock belongs to that interesting class alluded to above when speaking of the conglomerate granite from Granby. Nos. $\frac{11}{33}$ and $\frac{11}{37}$ are argillo-mica schist, and occur near the western limit of the indurated mica schists. No. $\frac{11}{44}$ is granite from Burke Mountain. It is not unlikely that this mountain is wholly composed of the same rock. We could see a white rock in the distance, upon the east side of the mountain, but were unable to examine the ledge. In the east part of Burke there is a ledge of talco-argillaceous slate, which is colored upon the Geological Map as the northern end of the clay slate formation. It runs N. 55° E., and dips 54° E. This vicinity is remarkable for the scarcity of ledges, and even of bowlders.

The next formation commences in the east part of Burke, and the familiar ledges of the calciferous mica schist show themselves. Upon the east branch of Passumpsic River, near East Burke, two ledges were noticed; one running N. 65° E., dipping 50° S.E.; the other running N. 40° E., and dipping 75° S.E. In Burke Hollow, the direction is N. 22° W., and the dip 20° N.E. This variety of schist (No. $\frac{11}{49}$) is continuous to Dummerston, and borders most of the way on indurated mica schist, though in a few cases a talcose schist range.

In the lower part of Sutton (No. $\frac{11}{50}$), a variety of limestone is the only kind of rock that was observed *in situ*. This specimen is from one mile west of Burke Hollow. Two miles west of this was found a porous kind of limestone, running N. 10° W., and dipping 6° E. The rock decomposes so easily, that it is very uncommon to find a ledge of it protruding above the surface of the earth. No. $\frac{11}{53}$ was taken from a large angular rock in the north-west part of Sutton, and near the ledge of granite in Sheffield. This and similar bowlders have a very contorted appearance, and are altered by contact with the granite. They occur upon the farm of Chauncy Fuller, and in that vicinity. In the north-west part of Sheffield, the schists appear to predominate; while the limestone is most abundant in Burke and Sutton. The dip is very small over this region, and appears to lie in its normal position, as deposited from Burke to the west part of Sutton; when we find a range of granite that has elevated the strata upon both sides so as to form an anticlinal. The same range of granite is found in the east part of Barton on the north, and extends through Sheffield into Wheelock and Danville on the south. One mile south of the height of land between Glover and Wheelock (in Sheffield, (?) there are beds of whetstone mica schist, from which the farmers in the neighborhood obtain their scythe-stones. The same beds appear upon the twelfth and thirteenth Sections. Their direction is N. 40° E., and their dip 50° N.W.

Between these beds and Glover village, the following is the order of the rocks: a narrow range of limestone; another bed of whetstone mica schist; a stratum almost entirely composed of hornblende crystals, (No. $\frac{11}{61}$); friable and granular limestones; mica schist, with garnets; mica schist with Adamsite in great abundance, associated with silicious limestone, and a large vein of hyaline quartz. One mile east of Glover village, the direction of the strata is N. 10° W., and the dip is 69° W. At the village, the direction changes to N. 15° W., and the dip 70°W. At Mr. Owen's house the direction of the strata of argillo-micaceous slate is N. 24° W. Ferruginous quartz is associated with it, and the dip—perhaps in consequence of this vein—is quite irregular.

One mile south of the village, we reach the west side of a synclinal axis; the direction of the schists and limestones being N. 25° W., and the inclination 60° E. The strata from which the Nos. $\frac{11}{63}$ to $\frac{11}{76}$ were obtained appear to be somewhat indurated, and their positions do not agree with the usual directions and inclinations of the ledges in this region. Two miles south of Glover, the direction of the strata is N. 25° E., and their dip 65° W. No. $\frac{11}{84}$ is from the bed of what was formerly known as Mud Pond. It is a union of quartz rock and mica schist. The rocks in the bed of Runaway Pond have a westerly dip, and are essentially the same rocks as those occurring in Glover.

As one approaches the former bed of Runaway Pond from Glover, he sees traces of the great flood in 1810, produced by the bursting of the barrier of Long (Runaway) Pond. No. $\frac{11}{77}$ is black silicious infusoria, which was left in the bed of the flood several miles north of the old pond, sometimes in beds several feet in thickness. No. $\frac{11}{78}$ is granite taken from a bowlder weighing two or three tons, which was brought a great distance from Long Pond by the same force. There was originally a pond (Clark's Pond on the State Map) of considerable magnitude, in the south part of Glover, the head of Barton River. It was 150 feet lower than Long Pond. It contained an immense quantity of peat (Nos. $\frac{11}{82}$, $\frac{11}{83}$), under which were large deposits of shell marl (No. $\frac{11}{81}$). The barrier that sustained this pond, was a bank of sand and gravel between two sand-hills of considerable elevation. The waters from Runaway Pond descended into this pond, and by their power washed away the embankment by which it was sustained. The mingled waters of both ponds passed on, leaving many acres of deep and exceedingly rich muck, and many acres of marl now lying "high and dry."

No. $\frac{11}{89}$ is silicious infusoria mixed with vegetable matters. It covers thirty or forty acres of the bed of Runaway Pond, and will shake, on passing over it, like a muck bed. When the waters passed out of the pond, this was mysteriously pressed up, and remained where it now lies. No vegetation covered it for many years, but it is now (1858) covered by meadow grass and bushes of inferior growth. No. $\frac{11}{90}$ is sand: a specimen of the material that composed the principal part of the original barrier, which was removed when the pond was drained. This sand is distinctly stratified in thin layers, much resembling clay. Dea. Loren Frost, of Coventry, who aided in cutting the trench to let off the water, measured the depth of this sand deposit, shortly after the inundation, and found it to be 125 feet thick. A brief account of the events that transpired at the time of this overflow, will be found in another part of the Report.

Immense bowlders of granite (No. $\frac{11}{91}$) are scattered for several miles westerly of Runaway Pond, in Greensboro. The hills about the old pond are three or four hundred feet above the bottom of the pond, and are composed of modified drift (sand and gravel) and bowlders.

At Mr. T. W. Wright's house, two miles westerly of Runaway Pond, the direction of the strata is N. 20° E., and the dip 50° W. Thus we have reached the west flank of another anticlinal in the same formation. The next variation in the position of the strata is near the north school house in Greensboro, where the direction is N. 30° E., and the dip 48° E. Another synclinal axis is thus before us, and in the west part of Greensboro the strata dip 75° E., with the strike of N. 30° E. This ledge (Nos. $\frac{11}{98}$, $\frac{11}{99}$) is contiguous to a large mass of granite two miles or more in width. But this range has not elevated the strata into an anticlinal; yet the strata upon the west side have much less inclination, the dip being 40° S.E., and the direction N. 50° E. In the northwesterly part of Greensboro, with the same position, occur the following varieties over a breadth of twenty rods: Nos. $\frac{11}{103}$ to $\frac{11}{108}$ granite, jointed silicious limestone, mica schist, jointed argillaceous slate and granite. In the east part of Craftsbury the dip decreases, becoming only 10° E. No. $\frac{11}{113}$ is jointed granite from a large vein, which often has the common rocks of the vicinity imbedded in it in fragments. Still further west the schists dip 10° W., with the strike N. 30° W. Thus there is here a small undulation, hardly sufficient to be termed a distinct anticlinal, especially as the strike varies west of the Presbyterian church to N. 50° W.— A few rods west of this church there is a bed of gneiss ten rods wide, much resembling granite, and a hill in the vicinity, known as "East Hill," has granite upon it (No. $\frac{11}{119}$.) At Ketchum's Mills, with the direction N. 30° W., the dip is 30° E. This rock borders on the range of concretionary granite, the production of which, as well as of the granite of Glover and Greensboro, seems to have disordered the general dip and direction between Runaway Pond and Craftsbury. Had this section passed five miles further north, the general dip would have been seen to be westerly, and the direction from N. 20°E to N. 40°E.

Upon this Section nineteen specimens of the different varieties of the curious concretionary granite of Craftsbury were obtained (Nos. $\frac{11}{121}$ to $\frac{11}{140}$.) The provincial name of "petrified butternuts" will give one a good idea of the appearance and shape of many of them as they appear in the specimens—black nodules set in white granite. Finer specimens are found at Craftsbury than elsewhere upon the same range, which extends from Stanstead, C. E. to Northfield, Vt. At Stanstead it contains a few nodules of mica and quartz, for the distance of half a mile. The nodules entirely disappear in the range from that place to Craftsbury, except in bowlders, doubtless originating there. From Craftsbury to Northfield, where the range ends, they are not found. There for half a mile they occur, much as at Stanstead. There are reasons for supposing that the concretionary granite at Craftsbury has been thrown up at different times, and veins of recent granite have been thrown up since, in which there are no nodules (No. $\frac{11}{122}$.)

No. $\frac{11}{140}$ is from a granite bowlder, from which stone enough has been split to build the walls of a State House. Of a similar bowlder in Greensboro, somewhat smaller, one of the best houses in the county has been constructed, and enough remained for all the underpinning of the neighborhood. No. $\frac{11}{141}$ is from a vein of quartz containing pyrites, cutting the strata of mica schist at an angle of fifteen degrees, and may easily be traced for several miles. No. $\frac{11}{143}$ is from a similar vein four feet wide, easily traced for a great distance. Its direction is N. 5° W.

In the vicinity of Craftsbury Common there are three trap dikes. The first is four feet wide, cutting the mica schist at an angle of fifteen degrees: the second is on the Common, three feet wide, and the structure is columnar. It contains much hornblende in distinct crystals. Its direction is N. 10° W., while the adjacent strata run from N. 10° E., to N. 20° E. The third dike is three feet wide. Nos. $\frac{11}{144}$, $\frac{11}{147}$ and $\frac{11}{146}$ represent these dikes. (Nos. $\frac{11}{148}$ to $\frac{11}{152}$) are from dikes of a granitic aggregate, which may be called firestone, on account of its power to withstand strong heat. There are five of those dikes; the first being ten feet wide, and running with the strata, one-fourth of a mile west of Craftsbury Common. The second cuts the strata at an angle of 20° to 30°, the dike running N. 10° W., and the strata N. 10° E., to N. 20° E. The third dike runs N. 9° W., is ten feet wide, and is only twenty rods west of the second. The fourth dike cuts across the third, and therefore is of more recent origin. The fifth dike of this description crosses the carriage road one-fourth of a mile south of William Scott's house, running N. 20° W. These dikes all decompose readily, and have a recent aspect, when compared with the other granites of the State.

The clay slates and interstratified beds of limestone which form the mass of rock in the central part of Craftsbury, run N. 10° E., to N. 30° E., and dip from 30° E., to 40° E. There is a black slaty limestone between the clay slate and talcose schist formations, which is probably the southern prolongation of the upper Helderberg limestone at Owl's Head in Canada. Not far from it is a bed of quartz rock (No. $\frac{11}{159}$) twelve feet wide, traceable for more than a mile north and south. By consulting the section it will be seen that there is another small undulation in the strata near the Common beside that already noticed; also that the upheaval of the concretionary granite has elevated the clay slate and mica schist into an anticlinal. Thus upon this formation, there are six distinct axes—an equal number of anticlinals and synclinals.

Upon the eastern border of the talcose schist in Craftsbury, there is a large granite bowlder (No. $\frac{11}{157}$) broken into two pieces; and one of the pieces is half turned round, four rods distant from the other part—each piece weighing a thousand tons. The direction of the talcose schist on the eastern limit is N. 30° E., and its dip 75° W. Thus it apparently overlies the clay slate as upon most of the other Sections. Novaculite schist (No. $\frac{11}{163}$) with a quartz stratum (No. $\frac{11}{162}$) are interstratified with each other in West Craftsbury; and they are succeeded on the west, upon the height of land near Craftsbury line, by talcose grit of a peculiar variety (No. $\frac{11}{164}$), occupying a breadth of half a mile. With it is granular quartz and whetstone talcose schist. Their strike is N. 30° E., and their dip 75° W. In the east part of Hydepark there are numerous moraine terraces, known by the people as "dry bowls:" so much do these depressions resemble the common bowl of the kitchen. Hence it is rather unfrequent to find ledges in this vicinity, uncovered by soil. Consequently it is difficult to know the precise position of the rocks for two or three miles, and upon the Section only those inclinations are protracted which were seen. In the northeast part of Hydepark, the talcose schist (novaculite) is vertical, and runs N. 30° E.— For a mile no rock is seen, and at Green River Falls the direction has changed to N. 25°E., and the dip is 41° E. Perhaps the situation of the schists upon Section X*a*, in this vicinity, will show that there has been some break or very sudden curve in the strata. A peculiar green talcose schist occurs in bowlders (No. $\frac{11}{167}$) at these falls; which is probably associated, when *in situ*, with Nos. $\frac{11}{171}$ to $\frac{11}{173}$, yet to be mentioned.

Green River at these falls is four or five times larger than at its junction with the La Moille River, six miles distant; much of the water being absorbed by the porous materials of this "dry bowl region." Nos. $\frac{11}{170}$ to $\frac{11}{173}$ were taken from a ferruginous bed of rock very much decomposed, half a mile west of the falls. This bed is said to be easily traceable to Morristown where it contains galena, and to Worcester where it contains gold.— The rock decomposes more readily than most talcose schists—so much so, that we have been unable to obtain a specimen of it unaltered, for the State Cabinet. T. J. Newland, has found very good hematite in this stratum at Wolcott. We should anticipate that this would be a good region for gold—that is, as good as could be expected in this part of Vermont. Two miles west of Green River Falls, the talcose schist runs N. 30° E., and dips 75° W. Nos. $\frac{11}{177}$, $\frac{11}{178}$ are both clay slate, and are from a well dug by Mr. Amos Dwinell. Their strike is N. 30° E., their dip vertical. These slates are doubtless the same with the clay slate found at Morristown, and in the Missisco valley east of Jay Peak, at Lowell and North Troy. The direction of this slate near Morrisville is N. 25° E., and the dip 85° W. At Cady's Falls in Morristown the same slate appears with precisely the same position. Near Hydepark talcose sandstone (Nos. $\frac{11}{181}$, $\frac{11}{182}$) is found running N. 37°E. and standing upon its edges. Talcose schist is interstratified with it. The cleavage planes in these vertical strata dip 73° E. At Hydepark village the position is unchanged. One mile west of the Court House the rock is gneissoid, and for some distance the direction is N. 25° E. and the dip 65° E. Pot-holes formed by the present channel of the La Moille are found in this vicinity from sixty to eighty feet above the ordinary water mark. Near the west line of Hydepark the rock is very much disturbed by small contortions so that we could not satisfactorily obtain its position. In the east part of Johnson the rock is whitish and dips 45° E. Upon the land of Robert Balsh two miles north of Johnson Center, there is a bed of limestone in talcose schist, the latter dipping 50° N.E., and running N. 40° W. The limestone is about fifteen feet wide, associated with some beds of green sandstone somewhat contorted. The limestone is principally white and blue; the former making black, and the latter white lime. Specimens are also abundant of pink and light-brown colors in the quarry. There is a vein of galena in this bed. About six rods west of the limestone is a green chloritic rock dipping 30°E. containing many pebbles and some crystals of galena, associated with thin bands of limestone. The rock is very heavy, whence we infer that there may be a small amount, at least, of lead in it, not discoverable to the eye. In this vicinity there is a cave about one hundred feet long. Probably it was once filled with limestone. There are also, not far from this range, beds of steatite in the northern part of Johnson, lying a little to the east of the limestone. About a mile north of Johnson there are two beds of quartzite, each six rods wide, and twenty rods apart (No. $\frac{11}{187}$.) Their position is about that of the talcose schist of Johnson village, which runs N. 10° E. and dip 60° E. A few rods west of the hotel in Johnson there are argillaceous pyritiferous and plumbaginous shales, corresponding, we imagine, to similar ledges near Cambridge Borough; themselves constituting the upper layer of the gneiss formation, or else the lower layer of the talcose schist. Upon the formation just passed over, there are three axes—two synclinals and one anticlinal.

The deposits of modified drift are unusually abundant in Hydepark and Johnson.—West of the village, these deposits diminish in amount, and the La Moille River passes through a narrow defile in the Sterling Mountains. Near Johnson Center commences the formation known as the gneiss and gneissoid rocks of the Green Mountains, with an easterly dip. They constitute a great anticlinal upon this section, and in consequence of the deep cut through the mountains the rocks can be examined more easily—and that at several different altitudes.

The general direction of the gneiss for two miles west of Johnson, is N. 20° E. It varies from N. 5°W. to N. 20°W. The dip varies from 45°–65° E. In the west part of Johnson

the strike is N. 25° E., the dip 65° E. Other positions of this gneiss are these: 30° E., 12° E., 10° E., N. 20° E., 30° W.

The western band of talcose schist appears east of the Center, dipping 63° W., and with the strike N. 20° E. The position is the same at the Center. At Cambridge Borough the strata are nearly perpendicular. This is the case until we reach the western limit of the formation. The talcose conglomerate occupies the area between the talcose schists and the Georgia slates, including several bands of quartz rock. In the east part of Westford, the strike is N. 20° E. The dip is irregular, but probably about 75° E. Half a mile east of the village of Westford, the dip is 85° E. At the village the strike varies from N. 10°–20° E. The dip is 85°W. The conglomerate is beautifully developed in the north part of Westford. Fragments of the Georgia slates are found among the pebbles. The following are several positions of the conglomerate: 74° E; N. 43° E., 80° S.E.; 77° E., N. 35° E.; N. 38° E., 70° E.: 53° E.; and N. 22°E., 24° E. There are at least three bands of quartz rock in the west part of Fairfax and the east part of Georgia, alternating with the conglomerate, the last one dipping about 25° E. This quartz rock may possibly be a repetition of the red sandrock series.

We come upon the Georgia group of slates next, as they are developed in the town of Georgia. The eastern part of the deposit consists of novaculite schist and shales dipping 40° S.E., and 60° S.E. East of the Plains village, the shales dip 18° S.E. At the west limit of the slate the *Barrandia Thompsoni*, etc., are found in the shales adjacent to the red sandrock series. Their dip is from 15°–20° S.E.

The character of the members of the red sandrock series, as well as their order, may be best known by consulting the names of Nos. 251 to 261 of this Section. The dip varies from 5°–10° E. The strata run beneath the Georgia slates. The uppermost member of the Hudson River group is a mass of white limestone without any appearance of stratification. The clay slate beneath, dips 12° S.E. This is at the shore of Lake Champlain in the north-west corner of Milton. Crossing over the water to Grand Isle, we find the whole of the north part of the town composed of Utica slate with a small easterly dip. In the south-west part of Grand Isle, Trenton limestone appears—Sister's Island is composed of one of these lower Silurian members.

SPECIMENS ILLUSTRATING SECTION XI.

GRANITE.

1 Talcose seams in protogine, Guildhall.
2 Protogine, Guildhall.
3 Protogine, brecciated, Guildhall.
4 Granite (bowlder), Guildhall.
5 Protogine, Guildhall.
6 Granite (bowlder), Guildhall.

MICA AND TALCOSE SCHISTS.

7 Hornblende rock (bowlder), Guildhall.
8 Mica schist, West Guildhall.
9 Mica schist, West Guildhall.
10 Granite (bowlder), West Guildhall.
11 Clay slate, West Guildhall.
12 Quartz (stratum), West Guildhall.
13 Talcose schist, West Guildhall.
14 Talcose schist, West Guildhall.
15 Contorted mica schist (bowlder), Granby.
16 Quartz and schist (bowlder), Granby.

17 Granite, (bowlder), Granby.
18 Mica schist, East Granby.
19 Talcose schist, Granby.
20 Mica schist, Granby.
21 Mica schist, Granby.
22 Mica schist with Adamsite, Granby.
23 Mica schist, Granby.
24 Argillo-micaceous slate, Granby.
25 Gneissoid conglomerate, Granby.
26 Pebble from conglomerate, Granby.
27 Mica schist, Granby.
28 Talcose schist, Granby.
29 Granite (bowlder), Granby.
30 Mica schist (bowlder), Victory.
31 Mica schist (bowlder), Victory.
32 Argillo-micaceous slate (bowlder), Victory.
33 Adamsite schist, with garnets and staurotide(?), Victory.
34 Quartz (stratum), Victory.
35 Mica schist, Victory.
36 Mica schist, west of Moose River, Victory.
37 Argillo-micaceous slate, West Victory.
38 Talcose schist, Victory.
39 Talcose schist, Victory.
40 Mica schist, Victory.
41 Granite (bowlder), Victory.
42 Mica schist (bowlder), Victory.
43 Indurated mica schist, east part of Burke.
44 Granite (bowlder), East Burke.
45 Granite, Burke Mountain, East Burke.
46 Quartz (bowlder), East Burke.
47 Clay slate, East Burke.

CALCIFEROUS MICA SCHIST.

48 Silicious limestone, East Burke.
49 Argillo-micaceous slate, Burke Hollow.
50 Silicious limestone, Sutton.
51 Porous limestone, Sutton.
52 Indurated talcose schist (bowlder), Sutton village.
53 Silicious limestone altered by granite, Northwest Sutton.
54 Silicious limestone, Sutton.
55 Silicious limestone, North-west Sheffield.
56 Mica schist, North-west Sheffield.
57 Granite, Sheffield.
58 Whetstone (mica) schist, Wheelock.
59 Silicious limestone, Wheelock.
60 Whetstone (mica) schist, Wheelock.
61 Hornblende, Wheelock.
62 Mica schist, Glover.
63 Silicious limestone, Glover.
64 Mica schist, Glover.
65 Mica schist with Adamsite, Glover.
66 Mica schist with garnets, Glover.
67 Mica schist with Adamsite, Glover Center.
68 Mica schist with Adamsite, Glover Center.
69 Quartz (vein), Glover Center.
70 Silicious limestone, Glover Center.
71 Argillo-micaceous schist, Glover.
72 Hyaline quartz (vein), Glover.
73 Silicious limestone, Glover.
74 Mica schist, Glover.
75 Mica schist, Glover.
76 Silicious limestone, Glover.
77 Silicious infusoria, Runaway Pond, Glover.
78 Granite (bowlder), Runaway Pond, Glover.
79 Silicious limestone, South Glover.
80 Mica schist with iron pyrites, South Glover.
81 Marl, Clark's Pond, South Glover.
82 Peat, Clark's Pond, South Glover.
83 Peat, Clark's Pond, South Glover.
84 Quartz with slate, Clark's Pond, South Glover.
85 Mica schist with Adamsite and iron pyrites, Runaway Pond, South Glover.
86 Silicious limestone, Runaway Pond, S. Glover.
87 Silicious limestone, Runaway Pond, S. Glover.
88 Mica schist, Runaway Pond, South Glover.
89 Infusoria with vegetable matter, Runaway Pond, South Glover.
90 Sand from the former barrier of Runaway Pond, South Glover.
91 Granite (bowlder), Runaway Pond, S. Glover.
92 Mica schist with adamsite, Greensboro.
93 Silicious limestone, Greensboro.
94 Quartz (vein), Greensboro.
95 Mica schist, Greensboro.
96 Mica schist with hornblende, Greensboro.
97 Clay slate, North Greensboro.
98 Silicious limestone, Greensboro.
99 Mica schist, Greensboro.
100 Granite, Greensboro.
101 Silicious limestone, Greensboro.
102 Indurated mica schist, Greensboro.
103 Granite, Greensboro.
104 Granite, Greensboro.

105 Jointed silicious limestone, Greensboro.
106 Mica schist, Greensboro.
107 Jointed clay slate, Greensboro.
108 Granite, Greensboro.
109 Mica (Adamsite) schist, Greensboro.
110 Argillaceous slate, East Craftsbury.
111 Silicious limestone, East Craftsbury.
112 Slaty silicious limestone, East Craftsbury.
113 Granite, jointed, East Craftsbury.
114 Silicious limestone, Craftsbury.
115 Clay slate, Pres. Church, Craftsbury.
116 Slaty silicious limestone, Pres. Church, Craftsbury.
117 Gneiss, Pres. Church, Craftsbury.
118 Clay slate, Craftsbury.
119 Granite, East Hill, Craftsbury.
120 Slaty micaceous limestone, Ketchum's Mills, Craftsbury.
121 Concretionary granite, Craftsbury.
122 Granite vein in the concretionary granite, Craftsbury.
123 Concretionary granite, Craftsbury.
124 Concretionary granite, Craftsbury.
125 Concretionary granite, Craftsbury.
126 Concretionary granite, Craftsbury.
127 Concretionary granite, Craftsbury.
128 Concretionary granite, Craftsbury.
129 Concretionary granite, Craftsbury.
130 Concretionary granite, Craftsbury.
131 Concretionary granite, Craftsbury.
132 Concretionary granite, Craftsbury.
133 Concretionary granite, Craftsbury.
134 Concretionary granite, Craftsbury.
135 Concretionary granite, Craftsbury.
136 Concretionary granite, Craftsbury.
137 Concretionary granite, Craftsbury.
138 Concretionary granite, Craftsbury.
139 Concretionary granite, Craftsbury.
140 Granite (bowlder), Craftsbury.
141 Quartz (vein), Craftsbury.
142 Silicious limestone with alluvial pebbles, Craftsbury.
143 Quartz (vein), Craftsbury.
144 Trap (dike), near Craftsbury Common.
145 Silicious limestone with pyrites, Craftsbury.
146 Clay slate, Craftsbury.
147 Trap dike with hornblende, Craftsbury Common.
148 Granitic aggregate, firestone, Craftsbury.
149 Granitic aggregate, firestone, Craftsbury.
150 Granitic aggregate, Craftsbury.
151 Granitic aggregate, Craftsbury.
152 Granitic aggregate, Craftsbury.
153 Silicious limestone with pyrites, Craftsbury.
154 Clay slate, Craftsbury.
155 Jointed clay slate, Craftsbury.
156 Trap dike, Craftsbury.
157 Granite (bowlder), Craftsbury.
158 Black slaty limestone (upper Helderb.), Craftsbury.
159 Quartz, Craftsbury.

TALCOSE SCHIST.

160 Talcose schist, Craftsbury.
161 Talcose schist, Craftsbury.
162 Quartz (stratum), Craftsbury.
163 Novaculite schist, Craftsbury.
164 Talcose grit, West Craftsbury.
165 Novaculite schist, Hydepark.
166 Talcose schist, Hydepark.
167 Green talcose grit (bowlder), Hydepark.
168 Talcose schist, Green River Falls, Hydepark.
169 Talcose schist and quartz, Hydepark.
170 Ferruginous bed containing galena and gold, Hydepark.
171 Ferruginous bed containing galena and gold, Hydepark.
172 Ferruginous bed containing galena and gold, Hydepark.
173 Ferruginous bed containing galena and gold, Hydepark.
174 Hornblende schist, Hydepark.
175 Talcose schist, Hydepark.
176 Talcose schist, Hydepark.

CLAY SLATE.

177 Green clay slate, Hydepark.
178 Clay slate, Hydepark.
179 Clay slate, Hydepark.
180 Clay slate, Cady's Falls, Morristown.

TALCOSE SCHIST.

181 Talcose sandstone, Hydepark.
182 Talcose sandstone, decomposing, Hydepark.
183 Talcose grit, Hydepark.
184 Gneissoid rock, Hydepark, west of village.
185 Gneissoid rock, West Hydepark.
186 Talcose schist, Johnson.
187 Quartzose schist, Johnson.
188 Gneissoid talcose schist, Johnson.
189 Limestone, North Johnson.
190 Compact brown limestone, North Johnson.
191 Talcose schist with feldspar and quartz pebbles, North Johnson.
192 Talcose schist, North Johnson.
193 Talcose schist, North Johnson.
194 Argillo-talcose schist, Johnson Center.
195 Clay slate, Johnson Center.

GNEISS AND GNEISSOID ROCKS.

196 Gneiss, Johnson Center.
197 Gneiss, Johnson.
198 Gneiss, Johnson.
199 Quartz (vein), Johnson.
200 Gneiss, West Johnson.
201 Gneiss, West Johnson.
202 Talcose schist, West Johnson.
203 Talco-micaceous schist, East Cambridge.
204 Clay slate, East Cambridge.
205 Gneiss, East Cambridge.
206 Gneiss, Cambridge.
207 Gneiss, Cambridge.

TALCOSE SCHIST.

208 Talcose gneiss, Cambridge.
209 Talcose schist with feldspar, Cambridge.
210 Talcose gneiss, Cambridge.
211 Talcose schist with magnetite and feldspar, Cambridge Borough.
212 Novaculite schist, Cambridge Borough.
213 Quartz grit (stratum), Cambridge Borough.
214 Whetstone (talcose) schist, Cambridge Borough.
215 Talcose grit, Cambridge Borough.
216 Gneiss, Cambridge Borough.
217 Talcose schist, Cambridge Borough.
218 Clay stones, Cambridge Borough.

TALCOSE CONGLOMERATES, Etc.

219 Talcose conglomerates, Cambridge Borough.
220 Sandstone, Cambridge.
221 Talcose conglomerate, Cambridge.
222 Talcose conglomerate, Cambridge.
223 Talcose sandstone, West Cambridge.
224 Talcose schist, West Cambridge.
225 Talcose schist, East Westford.
226 Talcose schist, East Westford.
227 Novaculite schist, Westford.
228 Talcose schist, Westford.
229 Conglomerate, Westford.
230 Pebble of clay slate from conglomerate, Westford.
231 Talcose sandstone, Fairfax Falls.
232 Talcose sandstone, Fairfax.
233 Talcose schist, Fairfax.
234 Talcose sandstone, Fairfax Center.
235 Novaculite schist, Fairfax.
236 Novaculite schist, Westford.
237 Novaculite schist, Westford.
238 Novaculite schist, Westford.
239 Novaculite schist, East Milton.
240 Quartz rock, Milton.
241 Quartz sandstone, Milton.
242 Novaculite schist, Milton.
243 Eolian limestone, near Milton Falls.
244 Gray sandstone, Milton Falls.
245 Gray quartz rock, Milton Falls.
246 Gray quartz rock, Milton Falls.

GEORGIA SLATE.

247 Novaculite schist, Georgia Depot.
248 Shale, Georgia.
249 *Barrandia Vermontana* (Hall), Georgia.
250 Shale, Georgia Plains.

RED SANDROCK SERIES.

251 Sandstone, Georgia.
252 Calcareous sandstone, Georgia.
253 Winooski marble, Milton.
254 Black breccia, Milton.
255 Black compact limestone with pyrites, Milton.
256 Brecciated limestone, Milton.
257 White sandstone, Milton.
258 Gray sandrock, Milton.
259 Winooski marble, Milton.
260 Gray dolomite, Milton.
261 Reddish limestone, Milton.

HUDSON RIVER GROUP.

262 Dove-colored limestone, Milton.
263 Calcareous slate, Milton.
264 Veins of calcite in Utica slate, Milton.

UTICA SLATE.

265 Utica slate, Hyde's Point, Grand Isle.
266 Utica slate, Ladd's Point, Grand Isle.
267 Serpentine (bowlder), Grand Isle.
268 Granite (bowlder), Grand Isle.
269 Encrinal limestone (bowlder), Grand Isle.
270 Encrinal limestone (bowlder), Grand Isle.
271 Hornblende (bowlder), Grand Isle.
272 Black limestone, Grand Isle.
273 Trenton limestone, Sister's Island.

APPENDIX TO SECTION XI.

274 Utica slate, Ball Island.
275 Utica slate, Ball Island.
276 Gray limestone (bowlder), Ball Island.
277 Sillery sandstone (bowlder), Ball Island.
278 Sillery sandstone (bowlder), Ball Island.
279 Assorted pebbles, North Hero beach.
280 Utica slate, S.W. Georgia.
281 Hypozoic limestone (bowlder), Georgia.
282 Winooski limestone (bowlder), Potter's Island.
283 Utica slate, Potter's Island.
284 Utica slate, Potter's Island.
285 Hypozoic gneiss (bowlder), Georgia.
286 Utica slate, Georgia coast.
287 Utica slate, Milton.
288 Utica slate, Kibbes' Point, South Hero.
289 Utica slate, Kibbes' Point, South Hero.
290 Utica slate with nodule of pyrites, Kinney's Point, North Hero.
291 Utica slate, North Hero.
292 Utica slate, North Hero, north part.
293 Utica slate, North Hero, north part.
294 Hypozoic gneiss (bowlder), South Hero.
295 Green sandstone (bowlder), South Hero.
296 Amygdaloidal trap, South Hero.
297 Hypozoic gneiss (bowlder), Ball Island.
298 Hypozoic gneiss (bowlder), Ball Island.
299 Calcareous sandstone, Georgia.
300 Hudson river shales, Georgia.
301 Contorted Hudson River shale, Georgia.

SECTION FROM CRAFTSBURY TO FAIRFIELD.

302 Concretionary granite, Craftsbury.
303 Talcose schist, Eden.
304 Talcose schist, Eden.
305 Talcose schist, Eden.
306 Talcose schist, Eden.
307 Talcose gneiss, Belvidere.
308 Talcose gneiss, Belvidere.
309 Serpentine, Waterville.
310 Serpentine, Waterville.
311 Steatite, Waterville.
312 Steatite, Waterville.
313 Steatite, Waterville.
314 Talcose schist, Waterville.
315 Talco-micaceous schist, Waterville.
316 Gneiss, Waterville.
317 Hyaline quartz, Waterville.
318 Hyaline quartz and schist, Waterville.
319 Limestone, Waterville.

320 Talcose schist, Bear's Den, Waterville.
321 Talcose schist, Bakersfield.
322 Talcose schist, Bakersfield.
323 Talcose schist, Fairfield.
324 Clay slate, Fairfield.
325 Winooski limestone, Fairfield.
326 Silicious limerock, Fairfield.
327 Novaculite schist, Fairfield.
328 Indurated novaculite schist, Fairfield.

MISCELLANEOUS SPECIMENS.

329 Mica schist, Maidstone.
330 Dolerite, Maidstone.
331 Gray sand, Maidstone.
332 Conglomerate syenite in a bowlder, Granby.
333 Conglomerate syenite with quartz pebbles, Granby.
334 Conglomerate syenite, Granby.
335 Conglomerate syenite, pebbles of mica schist, Granby.
336 Conglomerate syenite, with pebbles of mica schist, Granby.
337 Conglomerate syenite quartz pebble, Granby.
338 Conglomerate syenite, pebble talcose schist, Granby
339 Conglomerate syenite, pebble hornblende, Granby.
340 Conglomerate syenite, pebble hornblende schist, Granby.
341 Conglomerate syenite, pebble mica schist, Granby.
342 Conglomerate syenite, pebble chlorite schist, Granby.
343 Granite (bowlder), Granby.
344 Argillo-mica schist (bowlder), Granby.
345 Conglomerate syenite, pebble hornblende slate, Granby.
346 Specular iron ore, Wolcott.

SECTION XII.

This section extends from Bloomfield on Connecticut River to Point Au Roche on the west side of Lake Champlain, passing through Ferdinand, Brighton, Charleston, Brownington, Barton, Irasburgh, Lowell, Westfield, Montgomery, Enosburgh, Sheldon, Fairfield, St. Albans, and the islands of North Hero and Isle La Motte in Lake Champlain. It is represented in Plate XVII. Along Connecticut River in Bloomfield there is a range of hard mica schist standing upon its edge, or with a slight easterly leaning. This is less than two miles wide. Next the section passes over granitic rocks to Brighton. The first part of the rock passes over protogine, through Ferdinand to Nulhegan Mills, six miles from Connecticut River. This rock often contains fragments of slate imbedded in it, and is, no doubt, part of the stratum of conglomerate granite that appears at Granby and other places further south. The granite in Brighton varies from the light-colored to the dark-colored varieties.

In the western part of Brighton there is a narrow band of hornblende schist. At Dr. Coe's mine in Brighton on the south side of the river there is a vein of magnetic pyrites with sulphuret of molybdenum. There is said to be copper present.

The calciferous mica schist appears in the east part of Charleston near Breck's tavern, about five miles from Island Pond. Its strata have the direction of N. 25° E., and the dip 70° W. A mile or so west, hornblende schist, a member of the calciferous group, appears with the strike N. 10° W., and the dip 74° W. At William Clark's house ten miles from Island Pond the mica schist appears containing Adamsite, dipping 50° N.W. The granite from Willoughby Lake may possibly cross the route of this section in the east part of Brownington. It certainly, in some places, extends as far north. In the east part of Brownington there is a band of whetstone mica schist, No. 39, which is part of a belt extending from Morgan to Cabot. It dips 27° N.W. Some of the layers of silicious limestone found in this group of strata can be recognized for a great distance. One of them, No. 42, has a concretionary appearance, and has been traced from Holland to Cabot.

The exact order of rocks in this group in Brownington is admirably given in the Catalogue. The interstratification of the silicious limestones with the mica schist is well represented. The dip is generally to the west. Between East Brownington and Barton, at the falls, the following positions of strata were observed: N. 40° E., 27° N.W., N. 48° E., 27° N.W., 30° N.W., N. 50° E., 40° N.W., N. 70° E., 60° N., N. 70° E. 40° N. (church), and N. 30°–35° E., 50°–70° W.

All these rocks in Brownington, as well as elsewhere in this formation, are rapidly decomposing and form most excellent soil. The limestone in some places, and in others the clay slate associated with the schists, decays the most rapidly. The hornblende schists resist decomposition best, and are found upon the high hills.

There are several dikes and veins of unstratified rocks in Brownington. The most remarkable is the dike of limestone described elsewhere. Veins or beds of granite are common. Veins of quartz from six inches to four feet in width occur in all this region.

In the west part of the calciferous mica schist group clay slate is very common. It forms a range by itself presently. In its western part is a band of limestone dipping 46° N.W., which we suppose to be the continuation of the upper Helderberg limestone of Lake Memphremagog. Clay slate is found both on the east and west of this rock with the same position.

The section next crosses the eastern great belt of talcose schist. It forms a great synclinal basin. Serpentine and steatite are found in the schist at Lowell. In the west part of Lowell, Westfield and at Hazen's Notch, the rock is gneissoid. The dip is 80° southerly. Quartz rock is found on the west side of Hazen's Notch in Montgomery. For five or six miles the surface is strewed with bowlders of quartz rock.

Talcose schist with one or two narrow bands of clay slate occupies a wide region west of Hazen's Notch, as far as Fairfield. There are several small axes in the west part of the group. The boundary between the talcose schists and talcose conglomerate has not been carefully ascertained.

In the west part of Montgomery the direction of the talcose schist is N. 10° E. In the east part of Enosburgh, near the height of land, the direction is N. 30° E., dip 60°–70° E. At Enosburgh Center the direction is N. 30° E., and the dip 66° E. Half a mile west of the Center the direction is N. 78° E., dip 85° W. At West Enosburgh the direction is N. 60° E., and the dip 85° N.W. Half a mile east of Sheldon Four Corners the direction is N. 35° E., and the strata lean five degrees easterly. At the Corners we find talcose conglomerates, N. 38° E., 65° W. Twenty rods south of the ledge just examined are strata of talcose schist N. 35° E., 65° E. Half a mile south the strike is N. 35° E., and the dip 60° W. The position of the strata in this region is very irregular. In the north part of Fairfield the direction is N. 35° E., and the dip 60° E., also 65° E. No. 125 is clay slate one mile east of St. Rocks. The rocks at St. Rocks are quite variable in position, dipping both easterly and westerly. It is in the vicinity of good veins of red hematite, which were formerly mined. At Col. Burr's mine, one mile northwest of St. Rocks, the vein is three or four feet wide. The rock dips 80° S.E.

Near Sheldon Center, the rock dips 80° S.E. Two or three miles west of the village of Sheldon, the rock dips 60° S.E. In the west part of Fairfax the dip is 40° E.

The high hill east of St. Albans is mostly composed of a slaty-brown quartz, traversed by veins of quartz of different color, generally white. It dips 30° E. In the valley, in the east part of St. Albans, we come to the Georgia slate group. Its strata run N. 30° E., and dip 45° E. A trilobite has been found in this rock, but it was too obscure for identification with any known species. Aldis Hill is composed of quartz rock, sandstone and coarse limestone, dipping east. In the village of St. Albans, strata of the Georgia slate crop out, dipping 45° E. Next west we cross a band of coarse conglomerate, and then slate again, both dipping to the east. It is next succeeded by the red and gray sandstones of the red sandrock series, dipping east, from 5°–20°. At St. Albans Bay, we strike the Hudson River group, dipping from 4°–30° E. First we see the limestone which caps the series. This is at the village of St. Albans Bay. Then we see clay slate, in which, at Ram Island and in the west part of the town, is a band of silicious slate.

Utica slate next appears, underlying the Hudson River group. It is on North Hero Island. Its point of contact with the Hudson River group was nowhere seen. *Triarthrus Beckii*, *Crania filosa* and the common graptolites occur in it. Trenton limestone and Black River limestone are found next, in the north and middle parts of Isle La Motte, though not on the exact line of the Section. At the south end of the Island, the Chazy limestone appears, with a very small north-easterly inclination. The same rock is found at Point Au Roche in New York, the west end of the Section.

SPECIMENS ILLUSTRATING SECTION XII.

1 Mica schist with andalusite, Brunswick.
2 Mica schist with andalusite, Brunswick.
3 Sand with andalusite, Brunswick.
4 Mica schist, with andalusite, Brunswick.
5 Mica schist with Adamsite, Bloomfield.
6 Mica schist, with Adamsite, Bloomfield.
7 Protogine, Ferdinand.
8 Protogine, Nulhegan Mills, Ferdinand.
9 Granite, Island Pond.
10 Hornblende rock, Brighton.
11 Hornblende schist, Brighton.
12 Granite bowlder, Brighton.
13 Granite bowlder, Brighton.
14 Mica schist, Charleston.
15 Mica schist with Adamsite, Charleston.
16 Whetstone mica schist, Charleston.
17 Hornblende schist, Charleston.
18 Mica schist, Charleston.
19 Mica schist, Westmore.
20 Pyroxene, (?) Westmore.
21 Mica schist, Westmore.
22 Granite, Willoughby Lake.
23 Granite, Willoughby Lake.
24 Granite, Willoughby Lake.
25 Coarse granite, Willoughby Lake.
26 Coarse granite, Willoughby Lake.
27 Granite, Willoughby Lake.
28 Granite, Willoughby Lake.
29 Granite, Willoughby Lake.
30 Granite, Willoughby Lake.
31 Granite, Willoughby Lake.
32 Granite, Willoughby Lake.
33 Granite, Willoughby Lake.
34 Granite vein in granite, Willoughby Lake.
35 Limestone and feldspar, Willoughby Lake.
36 Mica schist, Willoughby Lake.
37 Hornblende dike, Willoughby Lake.
38 Mica schist, Willoughby Lake.
39 Whetstone mica schist, Westmore.
40 Whetstone mica schist, East Brownington.
41 Mica schist, East Brownington.
42 Silicious limestone, Prospect Hill, Brownington.
43 Gray limestone, Prospect Hill, Brownington.
44 Mica schist, Brownington.
45 Micaceous limestone, Brownington.
46 Limestone with pyrites, Brownington.
47 Trap dike with hornblende crystals, Brownington.
48 Mica schist, Brownington.
49 Micaceous limestone, Brownington.

50 Mica schist, Brownington.
51 Mica schist, Brownington.
52 Mica schist, Brownington.
53 Mica schist, Brownington.
54 Mica schist with Adamsite, Brownington.
55 Silicious limestone, Brownington church.
56 Mica schist with Adamsite, Brownington.
57 Micaceous limestone, Brownington.
58 Clay slate, Brownington.
59 Clay slate, Brownington.
60 Mica schist, Brownington.
61 Limestone with veins of calcite, Brownington.
62 Mica schist, Brownington.
63 Silicious limestone, Brownington.
64 Hyaline quartz, Brownington.
65 Decomposed limestone, Brownington.
66 Mica schist, Brownington.
67 Jointed granite, Brownington.
68 Granite, Brownington.
69 Limestone with veins of calcite, Brownington.
70 Limestone from a dike, Brownington.
71 Limestone from a dike, Brownington.
72 Limestone from a dike, Brownington.
73 Limestone from a dike, Brownington.
74 Mica schist, Brownington.
75 Jointed granite, Brownington.
76 Silicious limestone, Brownington.
77 Silicious limestone, Brownington.
78 Mica schist, Brownington.
79 Silicious limestone, Brownington.
80 Mica schist, Brownington.
81 Mica schist, Brownington.
82 Mica schist, Brownington.
83 Silicious limestone, Brownington.
84 Silicious limestone, with veins of calcite, Brownington.
85 Granite, Brownington.
86 Hyaline quartz, Brownington.
87 Silicious limestone, Brownington.
88 Syenitic trap, Brownington.
89 Silicious limestone, Irasburgh.
90 Clay slate, Irasburgh.
91 Granite, Irasburgh.
92 Granite, Irasburgh.
93 Granite, Coventry Narrows.
94 Clay slate, Coventry Narrows.
95 Upper Helderberg limestone, Coventry.
96 Clay slate, Coventry.

TALCOID SCHIST.

97 Novaculite, N.E. Irasburgh.
98 Clay slate, Arnold's Mills, Salem.
99 Hornblende (?) Coventry.
100 Talcose schist, Lowell, east of village.
101 Talcose schist, Lowell.
102 Serpentine (east range), Lowell.
103 Serpentine (west range), Lowell.

GNEISS AND GNEISSOID ROCKS.

104 Gneiss, Lowell.
105 Gneiss, Hazen's Notch.
106 Gneiss, Hazen's Notch.
107 Gneiss, Hazen's Notch.
108 Gneiss, west of Hazen's Notch.
109 Quartz rock, west of Hazen's Notch.
110 Gneiss, Montgomery.

TALCOSE SCHIST.

111 Talcose schist and quartz, Montgomery.
112 Contorted talcose schist, West Montgomery.
113 Talcose schist, East Enosburgh.
114 Talcose schist, Enosburgh Center.
115 Talcose schist, Enosburgh.
116 Talcose schist, West Enosburgh.
117 Talcose sandstone, E. of Sheldon Four Corners.
118 Impure reddish limestone, Sheldon Four Corners.
119 Milk quartz (vein), Sheldon Four Corners.
120 Novaculite schist, Sheldon Four Corners.
121 Talcose sandstone with feldspar, Sheldon.
122 Talcose schist, Sheldon.
123 Talcose schist, North Fairfield.
124 Whetstone (talcose) schist, North Fairfield.

CLAY SLATE.

125 Clay slate, Fairfield.
126 Green clay slate, St. Rocks, Fairfield.
127 Talco-argillaceous slate, Fairfield.
128 Green clay slate, Fairfield.

TALCOSE SCHIST.

129 Hematitic ore, Fairfield.
130 Talcose schist, Fairfield.
131 Red hematite, Burr's mine, Fairfield.
132 Rock containing the hematite, Fairfield.

TALCOSE CONGLOMERATE, Etc.

133 Quartz rock, Fairfield.
134 Talcose schist, Sheldon Center.
135 Quartz sandstone, Sheldon.
136 Talcose sandstone, W. Fairfax.
137 Ferruginous schist, W. Fairfax
138 Coarse conglomerate, N.W. Fairfax.
139 Coarse conglomerate, N.W. Fairfax.
140 Pebble from conglomerate, N.W. Fairfax.
141 Pebble from conglomerate, N.W. Fairfax.

GEORGIA SLATE.

142 Green shales, St. Albans.
143 Black shales, St. Albans.
144 Novaculite schist, St. Albans.

RED SANDROCK SERIES.

145 Variegated sandstone, St. Albans.
146 Quartz and sandstone, St. Albans.
147 Jointed sandstone, St. Albans.
148 Sandstone, St. Albans, west of village.
149 Calcareous sandstone, St. Albans.
150 Calcareous sandstone, St. Albans.
151 Winooski marble, St. Albans.
152 Compact limestone, St. Albans.
153 Red sandstone, St. Albans.
154 Red sandstone, St. Albans.
155 Novaculite schist (Georgia slate), St. Albans.
156 Gray sandstone, St. Albans.
157 Calcareous conglomerate (Georgia slate), St. Albans.
158 Calcareous conglomerate (Georgia slate), St. Albans.
159 Dove-colored limestone, St. Albans.
160 Sparry limestone, St. Albans.
161 Dove-colored limestone, St. Albans.
162 Champlain clay, St. Albans.
163 Armenian bole, St. Albans.
164 Mountain leather, St. Albans.
165 Champlain clay, St. Albans.

HUDSON RIVER GROUP.

166 Clay slate, St. Albans.
167 Breccia, Ram Island, St. Albans Bay.
168 Silicious slate, Ram Island, St. Albans Bay.
169 Silicious slate, Ram Island, St. Albans.
170 Silicious slate, St. Albans Point.
171 Silicious slate, St. Albans Point.
172 Clay slate, St. Albans Point.

UTICA SLATE.

173 Utica slate, Woods' Island.
174 Utica slate, Woods' Island.
175 Sillery sandstone (bowlder), Woods' Island.
176 Granite bowlder, Woods' Island.
177 *Graptolithus pristis*, Pelot's Point, N. Hero.
178 *Triarthrus Beckii*, N. Hero.
179 Utica slate with nodule of pyrites, N. Hero.
180 Utica slate with nodule of pyrites, N. Hero.
181 Nodular iron pyrites, N. Hero.
182 Red sandstone (bowlder), N. Hero.
183 Black limestone (bowlder), N. Hero.

CHAZY LIMESTONE.

184 Chazy limestone, S.E. corner of Isle La Motte.
185 Black marble, Hill's quarry, Isle La Motte.
186 Black marble, Hill's quarry, Isle La Motte.
187 Pebbles, Isle La Motte beach.
188 Red granite (bowlder), Isle La Motte.
189 Chazy limestone with fossils, Isle La Motte.
190 Chazy limestone with fossils, Isle La Motte.
191 Black marble, Hill's quarry, Isle La Motte.

192 Black marble, Cook's quarry, Isle La Motte.
193 Black limestone, Fisk's quarry, Isle La Motte.
194 Encrinal limestone, Fisk's quarry, Isle La Motte.
195 Black limestone, Fleury's quarry, Isle La Motte.
196 Black limestone, Fleury's quarry, Isle La Motte.
197 *Maclurea magna*, Isle La Motte.
198 Concretionary limestone, Isle La Motte.
199 Slaty limestone, Point au Roche, N. Y.
200 Limestone burnt for lime, Point au Roche, N. Y.
201 Limestone burnt for water cement, Point au Roche, N. Y.

APPENDIX TO SECTION XII.

202 Utica slate, Knight's Island.
203 Potsdam sandstone (bowlder), Knight's Island.
204 Hudson River slate, Butler's Island.
205 Veins of quartz in clay slate, Butler's Island.
206 Dove-colored limestone, Rich's, Swanton.
207 Red sandstone, Swanton.
208 Winooski limestone, Swanton.
209 Winooski limestone, Swanton.
210 Winooski limestone, Swanton.
211 Winooski limestone, Swanton.
212 Winooski limestone, Swanton.
213 Novaculite schist, Sheldon.
214 Talcose sandstone, Sheldon.
215 Novaculite schist, East Swanton.
216 Silicious limestone, East Swanton.
217 Novaculite schist, Sheldon.
218 Novaculite schist, N.E. Swanton.
219 Clay stone, Swanton Falls.
220 Clay stone, Swanton Falls.
221 Clay stone, Swanton Falls.
223 Clay stone, Swanton Falls.
224 Clay stone, Swanton Falls.
225 Clay stone, Swanton Falls.
226 Clay stone, Swanton Falls.
227 Clay stone, Swanton Falls.
228 Clay stone, Swanton Falls.
229 Clay stone, Swanton Falls.
230 Clay stone. Swanton Falls.
231 Clay stone, Swanton Falls.
232 Clay stone, Swanton Falls.
233 Clay stone, Swanton Falls.
234 Clay stone, Swanton Falls.
235 Clay stone, Swanton Falls.
236 Clay stone, Swanton Falls.
237 Silicious limestone, Albany.
238 Silicious limestone, Albany.
239 Silicious limestone, Albany.
240 Granite, Coventry.
241 Granite with clay slate, Coventry.
242 Decomposing granite, North Salem.
243 Hornblende schist, North Salem.
244 Hornblende schist, North Salem.
245 Granite, North Salem.
246 Argillo-micaceous schist, Lemmington.
247 Mica schist, Lemmington.
248 Jointed mica schist, Columbia, N. H.
249 Jointed mica schist, Columbia, N. H.
250 Compact gray limestone, Columbia, N. H.
251 Compact gray limestone, Columbia, N. H.

SECTION XIII.

This Section commences at the northeast corner of the State, and passes west to Rouse's Point in New York, very near the Canada line. It passes through the towns of Canaan, Averill, Avery's Gore, Warren's Gore, Warner's Gore, Norton, Holland, Derby, Newport, Troy, Jay, Richford, Berkshire, Franklin, Highgate, Swanton and Alburgh. It is illustrated by colors in Plate XVII.

Mica schist is the most eastern rock in this Section. It occupies the valley of Connecticut River. At the east end of the Section it dips from 80°–65° N.W. Further west its angle of inclination is 46° N.W. At Canaan village the dip is from 25°–69° E. Thus here there is a synclinal axis. We have also an anticlinal, for the western part of the band dips 60° N.W. Thick veins of protogine are associated with it also. Some argillo-micaceous schists are found three miles west of Connecticut River, dipping 82° N.W.—

Five miles west of Connecticut River, and also in Averill, we find whetstone mica schist. But the greater part of Canaan is made up of granite.

The whetstone schist in Averill, extends from Burford or Hereford, C. E., and passes through the granite to Sheffield. In some places it is highly valued for scythe-stones. In no place is the stratum more than one hundred feet wide.

No settlements are found between Canaan and Norton, the entire region being " hunting and fishing ground." The surface is less broken than in most parts of the State, and the soil of medium quality, and not very strong. It will doubtless soon be settled. A hundred good farms might be made on the ground passed over between Canaan and Norton. Leach Pond, in the northern part of Canaan, covers about one and a half square miles [on the Map it is represented much too large.] Little Leach Pond, in Averill, which discharges its waters into Great Leach, and through that into Connecticut River, covering nearly a square mile, lies on the east, and very near to Great Averill Pond, and on the same level with it. This pond or lake, covers from four to six square miles. It is about three and a half miles in length from north to south, and varies from one to two miles east and west. [It is represented on the Map much smaller than it should be.] A fourth part of it is in Norton. Little Averill lies west of Great Averill, is about half the size, and discharges its waters into it. These ponds are from about 1300 to 1400 feet above the ocean, and are surrounded by many thousand acres of arable land. Excellent fish abound in these ponds. Both Great and Little Averill ponds furnish very good mill sites, and water power adequate to the wants of a large population.

Hitherto there has been no road through this territory, but efforts are now being made to accomplish this object. From the western part of Canaan, to Holland, an excellent road may be constructed, with less grade than in any other part of the State, for an equal distance (except in the valleys of streams), with which we are acquainted. From the Connecticut valley at Canaan, to the west part of that town, there is considerable rise, which, however, may be in part avoided by following up a stream which rises in the east part of Averill, and flows easterly, into the Connecticut River.

The waters of Leach, Averill and Norton Ponds, are remarkably clear and soft. There are very few clams or other shell fish in any of them, showing the deficiency of carbonate of lime. The sand at Great Averill (No. 18), is more beautiful than any other we have found in Northern Vermont. It would doubtless make excellent glass.

Land owners would greatly advance their own interest, by constructing a mill at the outlet of Great Averill Pond, and a good road from thence to both Canaan and Holland. This outlet is only five miles from the Grand Trunk Railway station at Barnston and Burford, C. E. Little Averill pond is only a few miles from the track of the railroad, and the *way* station at Norton Pond. The amount of lumber that would thus be made accessible, is immense. Excellent quarries of granite and gneiss abound in all this region through which the railroad now passes from Barnston to Island Pond. Mills for sawing lumber have already been erected on the stream that issues from Norton Pond, within a few rods of the railroad, capable of doing a large amount of business.

No *high* mountain is found in this region. Black mountain, in Avery's Gore, is the highest, but does not probably exceed 800 or 1000 feet above Norton Pond. It is an interesting fact, that the head waters of the Clyde and also of Norton Pond—one flowing

south and the other north—and the head waters of Averill Stream and Leach Lake, are nearly on the same level. The former flow into the St. Lawrence, and the latter into the Connecticut.

From the west part of Canaan to the east part of Holland the rocks are almost entirely granite and protogine. Protogine is found in Canaan and in Avery's Gore. On the east side of Morgan Lake the granite is traversed by numerous joints, which make the rock greatly to resemble gneiss. It is remarkably well situated for a granite quarry, and immense tables of the rock can be secured with very little labor. These tables incline westerly from two to twenty degrees.

The mica schist first seen west of the granite in Morgan and Holland has been much indurated. Near Morgan Four Corners the strike of the mica schist is N. 40° E., and the dip is 20° N.W. No. 27 is scapolite rock. There is a stratum of it a few inches thick in Morgan and Holland. In the north part of Morgan the schist dips 40° N.W. No. 29 is clay slate in the south-east part of Holland, interstratified with silicious limestone, hornblende and mica schists, dipping 35° north-westerly. These rocks are *in situ* from Holland to Derby. The granite nearest the schists in Holland is jointed. In Holland may be found one of the best soils in the State. In the west part of Holland the strike is N. 23° E., and the dip 40° W. From this place to Lake Memphremagog the strike and dip are both changed from what is usual in this region, the strike being often west of north; whereas the general course of the strata in north-eastern Vermont is from twenty to forty degrees east of north. The strata in the eastern part of Derby on Adams' hill are perpendicular, and thence to the lake the dip is east instead of west. A few miles south the dip is westerly, and also on the north. South of Derby in the central part of Salem there is a mass of granite. This mass is two miles wide and four long. The question arises naturally whether these strata may not have been disturbed by the protrusion of this granite.

In the west part of Holland, near a school-house, about 1300 feet above the ocean the strata dip 42° W. Clay slate is occasionally found interstratified with these beds of mica schist and limestone. The micaceous limestone still further west in Holland runs N. 10° W., and dips 60° W. The strata next succeeding are vertical. At Derby Center the dip is from 40°–60° E. South of Derby Center the dip is westerly. Here there is an interesting alternation of granite, mica schist and limestone, the last sometimes fossiliferous. The details are given elsewhere, and the order of strata is given in Fig. 19. The specimens illustrating this section are Nos. 38 to 55.

In the west part of Derby there is a range of granite fifty rods wide. This range commences in Stanstead, where it is concretionary, and extends southerly through Craftsbury perhaps to Northfield. Two miles west of Derby Center, 1000 feet above the ocean, the strike is N. 30° E., and the dip 80° south-easterly. One mile further west the dip is 70° S.E.

The valley of Lake Memphremagog is occupied by clay slate. The strata upon the east side of the belt dip at a high angle to the east, and those on the west side dip about 75° W., thus forming an anticlinal axis. The upper Helderberg limestone forms a bed in the western part of the clay slate. Overlying both these rocks is a narrow bed of remarkably coarse conglomerate. This is near Charles Wright's house in Coventry. We have been disposed to regard this conglomerate as a part of the talcose schist formation, but it is totally unlike any conglomerate in this group elsewhere in the State. The soil covers its connection with the adjacent rocks, and it is not found at any more favorable location. The region on the west side of Lake Memphremagog needs a careful exploration in order to ascertain more certainly the relative position of the upper Helderberg limestone, the clay slate and the talcose schist.

Talcose schist extends from Newport to Franklin, forming two synclinal axes, and an anticlinal axis supporting the synclinals. At its east border it is inclined 60° W. Several beds of excellent novaculite or honestone occur in Newport two miles west of the lake, dipping 70° N.W. Another good locality of novaculite occurs three miles west of the village of Coventry. There are several beds of it, each ten or twelve feet thick. A narrow band of granite is found in Newport. The talcose schist has a uniformly westerly dip as far as the Missisco River in Troy where the strata are vertical. The increase of the dip is gradual. At the West Falls on the Missisco the schist becomes conglomerate.

There are two great ranges of serpentine and steatite in Troy, one on each side of the Missisco River, which are represented by Prof. Adams and Mr. Hall as probably forming a synclinal basin, with the steatite mostly beneath the serpentine. At the village of North Troy the section crosses a narrow range of clay slate dipping 65° E. There are three of these beds in the talcose schist. Perhaps these bands may connect with the belts of clay slate employed by the Canada Survey to indicate the position of the several anticlinals of the talcose group of rocks as they extend into Canada. The second band of clay slate runs into Richford from Montgomery, and the third appears near the western border of the group; neither of which are represented upon the colored section.

West of Troy there seems to be an anticlinal in the talcose schist. Possibly the anticlinal belongs to an underlying gneissoid rock. We give all the observations which seem to establish this view of the position of the strata. Five miles west of North Troy the strata dip 55° S.E. At the most northern bend of the Missisco River in Canada a ledge of schist appears, too distorted perhaps to represent the general position of the strata in its neighborhood, whose strata dip 35° southerly. On the summit of Jay Peak, Prof. Adams describes the strata as nearly perpendicular, leaning slightly to the east. Nearly north of Jay Peak, in Richford, the dip is 75° N. W. Near East Richford the strata dip 38° N.W. At Richford village the dip is 76° N.W. This westerly dip continues into Berkshire, gradually rising till the strata stand upon their edges. Then through Berkshire and Franklin the dip is to the east, growing less and less as we proceed west.

Serpentine and steatite occur at Wright's Mills, in the south part of Richford, on the west side of the anticlinal. In the northeast part of Berkshire there is a bed of manganese ore 10 to 15 feet wide, on Mr. Mitchell's land. Three-fourths of a mile south-west, there is a bed of red hematite. Another bed of hematite occurs half a mile from the latter locality. The two latter beds are on William Hill's farm.

The talcose schist in Berkshire, for four miles on the route of the Section, is filled with epidotic nodules, often containing specular iron and calcite. There is a small amount of heavy spar in West Berkshire. Between West Berkshire and Franklin the rock seems to be a species of obscure novaculite schist. At West Berkshire the dip is 35° S.E. West of the village of Franklin, where the strata dip 25° easterly, there are numerous little bands or strata of limestone, interstratified with the talcose schist. A calciferous rock is abundant in Franklin.

The rocks succeeding the talcose schists (with some conglomerate patches in its western part), is the Georgia group of clay slates. Its dip varies from 40°–60° E.—The next group is the red sandrock series. At Keyes' Falls, and in the north part of Highgate, this rock is a remarkably compact breccia, forty feet thick. It dips from 10° to 20° S.E. Some clay slates appear to be interstratified with this rock. Two other members of this series, next in order, are silicious limestone and calcareous sandstone. For 40 or 50 rods east of the trilobite locality at Mr. Church's house, the following is the order of the strata:

Light colored limestone, containing grains of sand.
Light-blue limestone.
Beds of white sandstone, resembling Potsdam sandstone.
Limestone.
Red and brownish-red sandstone.
Fine red limestone.
Coarse, gray, silicious limestone.

All these strata dip about 20° E. The stratigraphical relations of the red sandrock of Highgate have been fully treated of under the description of that rock.

The rocks between the red sandrock and the Trenton limestone are coarse, brecciated limerocks, with occasional beds of almost white, pure limestone, sometimes containing coralline forms. We have referred them to the Hudson River group. The Trenton and Black River limestones appear in several folds in the region of Highgate Springs. They are minutely described in Part II. West of Highgate Springs, over the greater part of Hog Island, in Swanton, the rocks are entirely concealed by Champlain clays. Alburgh is entirely composed of Utica slate. Much of the town is covered by Champlain clays.

SPECIMENS ILLUSTRATING SECTION XIII.

1 Argillo-micaceous schist, Canaan.
2 Argillo-micaceous schist, Canaan.
3 White quartz, Canaan.
4 Argillo-micaceous schist, Canaan.
5 Mica schist, Canaan.
6 Mica schist, Canaan.
7 Mica schist, Canaan.
8 Mica schist (sandstone), Canaan.
9 Soil, Canaan.
10 Jointed mica schist, Canaan.
11 Mica schist, Canaan.
12 Protogine, Canaan.
13 Mica schist, Canaan.
14 Argillo-micaceous schist, W. Canaan.
15 Mica schist, Canaan.
16 Whetstone mica schist, W. Canaan.
17 Whetstone mica schist, East Averill.
18 Sand, Great Averill Pond.
19 Granite, Averill.
20 Protogine, Avery's Gore.
21 Granite, Warren's Gore.
22 Granite, Norton.
23 Jointed granite, Morgan.
24 Jointed indurated mica schist, Morgan.
25 Whetstone mica schist, Morgan Four Corners.
26 Mica schist, Morgan Four Corners.
27 Scapolite rock (?), Morgan.
28 Granite, Morgan.
29 Clay Slate, S. East Holland.
30 Jointed granite, S. East Holland.
31 Silicious limestone, Holland.
32 Mica schist, Holland.
33 Silicious limestone, Holland.
34 Micaceous limestone, W. Holland.
35 Gray limestone, W. Holland.
36 Granite and gneiss, E. Derby.
37 Clay slate, Derby Center.
38 Mica schist with Adamsite, Derby.

39 Quartzose grit with hornblende, Derby.
40 Granite, Derby.
41 Silicious limestone, Derby.
42 Granite, Derby.
43 Gray limestone, Derby.
44 Limestone with encrinites, Derby.
45 Silicious limestone, Derby.
46 Granite, Derby.
47 Hornblende schist with garnets, Derby.
48 Mica schist with Adamsite, Derby.
49 Granite, Derby.
50 Mica schist with Adamsite, Derby.
51 Gray limestone, Derby.
52 Gray limestone, Derby.
53 Mica schist with Adamsite, Derby.
54 Granite, Derby.
55 Mica schist, Derby.
[Nos. 38 to 55 illustrated in Fig. 19.]
56 Granite, Derby.
57 Jointed mica schist, W. Derby.
58 Silicious limestone, W. Derby.
59 Jointed silicious limestone, W. Derby.
60 Jointed granite, W. Derby.
61 Silicious limestone, W. Derby.
62 Jointed clay slate, W. Derby.
63 Silicious limestone, W. Derby.
64 Granite, Newport.
65 Clay slate, Newport.
66 *Zaphrentis* (Upper Helderberg), Owl's Head, Canada.
67 Jointed granite, Newport.

TALCOSE SCHIST.

68 Talcose schist, Newport.
69 Novaculite, Newport.
70 Novaculite, Newport.
71 Novaculite, Newport.
72 Novaculite, Newport.
73 Novaculite, Newport.
74 Novaculite schist, Newport.
75 Epidotic talcose schist, Newport.
76 Asbestus, &c., Newport.
77 Indurated talcose schist, Newport.
78 Micaceous conglomerate, Newport.
79 Talcose schist, Newport.
80 Concretion in sand, Coventry.
81 Concretion in sand, Coventry.
82 Concretion in sand, Coventry.
83 Claystone, Coventry.
84 Claystone, Coventry.
85 Claystone, Coventry.
86 Conglomerate, Coventry.
87 Conglomerate, Coventry.
88 Conglomerate, Coventry.
89 Pebble from conglomerate, Coventry.
90 Decomposing mica schist from conglomerate, Coventry.
91 Decomposing conglomerate, Coventry.
92 Novaculite, West Coventry.
93 Novaculite, West Coventry.
94 Blue compact quartz (bowlder), W. Coventry.
95 Mica schist (bowlder), West Newport.
96 Jointed granite, South-west Newport.
97 Indurated talcose schist, West Newport.
98 Talcose schist, West Newport.
99 Talcose schist, East Troy.
100 Talcose grit, Troy.
101 Talcose grit and porous quartz, Troy.
102 Talcose schist, Troy.
103 Talcose grit, High Falls, North Troy.
104 Talcose schist, West Falls, Troy.
105 Talcose conglomerate, West Falls, Troy.
106 Clay slate, High Falls, North Troy.
107 Plumbaginous shales, North Troy.
108 Gray shales, North Troy.
109 Talcose schist, Troy.
110 Talcose schist and soapstone, Troy.
111 Serpentine, Troy.
112 Steatite, North Troy.
113 Serpentine, North Troy.
114 Impure steatite, North Troy.
115 Talcose schist, North Troy.
116 Native magnet, South Troy.
117 Impure steatite, South Troy.
118 Decomposing talcose schist, South Troy.
119 Indurated talcose schist, South Troy.
120 Serpentine, South Troy.
121 Talcose schist, etc., South Troy.
122 Asbestus, South Troy.
123 Serpentine, South Troy.
124 Carbonate and oxyd of iron, South Troy.
125 Serpentine, South Troy.
126 Serpentine, Jay.
127 Serpentine, Jay.
128 Chromic iron, Jay.
129 Soapstone, Canada.
130 Mica schist, Potton, C. E.

131 Gneiss, Richford.
132 Talcose schist with a little feldspar, Richford.
133 Talcose schist, Richford village.
134 Talcose schist, Richford village.
135 Talcose grit, Richford.
136 Talcose schist (bowlder), Richford.
137 Talco-micaceous schist, N.E. Berkshire.
138 Talcose grit colored by manganese ore, Rosseau's, Berkshire.
139 Micaceous iron, Wm. Hill's, Berkshire.
140 Talcose schist, with iron ore, W. Hill's, Berkshire.
141 Geodic talcose schist, Berkshire.
142 Talcose schist, Berkshire.
143 Talcose schist, Berkshire.
144 Epidotic talcose schist, Berkshire.
145 Epidotic talcose schist, Berkshire.
146 Micaceous iron ore, Searl's, Berkshire.
147 Talcose schist, Berkshire.
148 Talcose schist, West Berkshire.
149 Talcose schist, West Berkshire.

AGE OF TALCOSE CONGLOMERATES, ETC.

150 Novaculite schist, Franklin Center.
151 Novaculite schist, Franklin.
152 Novaculite schist with limestone, Franklin.
153 Novaculite schist, North Franklin.
154 Novaculite schist, North Franklin.
155 Limestone, Franklin.
156 Limestone, Franklin.
157 Limestone with talcky seams, Franklin.
158 Limestone with talcky seams, West Franklin.

GEORGIA SLATE.

159 Decomposing shale, East Highgate.
160 Shale with nodules of limestone, E. Highgate.
161 Novaculite shale, Highgate Falls, (upper.)
162 Shale, Highgate.
163 Shale with calcite, Highgate village.
164 Shales, Highgate.

RED SANDROCK SERIES.

165 Breccia, Highgate village.
166 Breccia, Highgate, two miles east of Saxe's Mills.
167 Compact conglomerate, Highgate.
168 Silicious limestone, Highgate.
169 Calcareous sandstone, Highgate.
170 Crushed shales, Highgate. (See Fig. 247.)
171 Crushed shales, Highgate. (See Fig. 247.)
172 Sandstone, near Saxe's Mills.
173 Dark sandrock, Highgate.
174 Gray sandrock, Highgate.
175 Decomposing sandstone, Highgate.
176 Quartz sandstone, Highgate.
177 Sandstone, Highgate.
178 Calcareous sandrock, Highgate.
179 Gray sandrock, Highgate.
180 Reddish gray sandrock, Highgate.
181 Red sandstone, Highgate.
182 Red sandstone with trilobites, Highgate.
183 Red sandstone, Highgate.
184 Red sandstone, Highgate.
185 Light red sandstone with limestone, Highgate.
186 Variegated sandrock, Highgate.
187 Red sandrock, Highgate.
188 Light red sandstone, Highgate.
189 Light red sandstone, Highgate.
190 Dark colored limestone, Highgate.
Nos. 173–190 are a section of the hill east of Church's house.

HUDSON RIVER GROUP.

191 Brecciated limestone, Highgate.
192 Brecciated limestone, Highgate.
193 Dove-colored limestone, Highgate.
194 Gray limestone, Highgate.
195 Coralline limestone, Highgate.
196 Coralline (?) limestone, Highgate.
197 Dove-colored limestone, with veins of calcite, Highgate.
198 Coralline limestone, Highgate.
199 Dove-colored limestone, near Highgate Springs.
200 Dove-colored limestone, near Highgate Springs.
201 Impure limestone, near Highgate Springs.
202 Dove-colored limestone, east of Highgate Springs.

TRENTON AND BLACK RIVER LIMESTONES.

203 Limestone with grains of quartz, Highgate Springs.
204 *Columnaria sulcata*, Highgate Springs.
205 Claystone concretion, Saxe's Mills.
206 Bog iron ore, Highgate Springs.
207 Limestone with grains of quartz, Highgate Springs.
208 Jointed trap (dike), Highgate Springs.
209 Limestone with veins of calcite, Highgate Springs.
210 Black compact limestone, Highgate Springs.
211 Seam of dove-colored limestone, Highgate Springs.
212 Sparry limestone, Highgate Springs.
213 Dove-colored limestone, Highgate Springs.
214 Trenton limestone with fossils, Highgate Springs.
215 Trenton limestone with fossils, Highgate Springs.
216 Black limestone, Highgate.
217 *Chætetes lycoperdon*, Highgate.
218 Trenton limestone with fossils, Highgate.
219 Black compact limestone, Highgate.
220 Black limestone, Highgate.
221 Trenton limestone, with fossils, Highgate.
222 Gray limestone, Highgate.
223 Limestone with fossils, Highgate.
224 Gray limestone with green coating, Highgate.

UTICA SLATE.

225 Utica slate, East Alburgh.
226 Hypozoic gneiss (bowlder), East Alburgh.
227 Utica slate, West Alburgh.
228 Calcareous tufa, Derby.

PART VI.

LOCALITIES OF MINERALS IN VERMONT.

BY E. HITCHCOCK, JR.

There are four grades in this Catalogue:

1. Simply written, denotes occurrence.
2. Good Specimens, *italicised.*
3. Remarkably good, noted by an exclamation point (!).
4. Best — superlative degree — by two exclamation points (!!).

The useful minerals—as Soapstone, Serpentine, Roofing Slate, Iron, &c.—are estimated only for Vermont; and the above marks denote to which of four classes they belong, from worthless to most excellent.

Remark. Occurrence of Limestone which is good for burning for lime is *italicised*, and two exclamation points (!!) for Marble.

Addison. *Iron Sand*, Iron Pyrites.

Albany. *Granite*, *Roofing Slate*, Marl (!).

Alburgh. Quartz, Iron Pyrites, Marl.

Arlington. Tourmaline, Magnetic Iron, Pyrites.

Athens. Soapstone (!!), Talc, *Rhomb Spar*, Garnet, Actinolite.

Bakersfield. *Limestone.*

Baltimore. *Serpentine*, Limestone, Iron Pyrites (!!).

Barnard. *Marl.*

Barton. *Granite*, Amianthus.

Barnet. Graphite, Granite, Marl.

Barre. *Granite*, Marl.

Bellows Falls (Rockingham.) Kyanite, Wavellite, Native Alum, Pinite, Quartz, Rubellite, Staurotide, Prehnite, Chiastolite, Adularia, Black Tourmaline, Silver Mica, *Indicolite*, Fluor, Calcite, Fibrolite, Roofing Slate.

Belvidere. Soapstone, Chlorite.

Bennington. *Pyrolusite*, *Brown Iron Ore*, Stalactites, *Pipe Clay*, *Yellow Ochre*, Psilomelane.

Berkshire. *Epidote*, Red Hematite, Specular Iron, Magnetic Iron.

Bethel. *Actinolite*, Talc, Chlorite, Octahedral Iron, *Garnet*, *Rutile*, *Brown Spar*, *Soapstone*, Granite.

Bradford. Granite.

Braintree. Mispickel, Granite, Soapstone.

Brattleboro. Mica, Tourmaline, Zoisite, *Roofing Slate*, Rutile, Scapolite, Actinolite, Spodumene.

Brandon. Hematite, *Pyrolusite*, Pipe Clay, Yellow Ochre, Braunite, *Psilomelane*, Lignite Marble (!!), Plumbago, Galena, Copper Pyrites.

Bridgewater. *Native Gold*, Talc (!!), *Dolomite*, Bitter Spar (!!), *Magnetic Iron*, Soapstone (!!), Chlorite, Native Copper, Blende, Galena (containing 25 oz. silver to ton, *Mallet*), Blue Spinel, Copper Pyrites.

Brighton. Magnetic Iron.

Bristol. *Rutile*, Brown Hematite, Manganese Ores, Magnetic Iron.

Brookfield. *Mispickel*, *Iron Pyrites*, Marl.

Brownington. Granite.

Burlington. Calcite, Calcareous Tufa.

Cabot. Garnet, *Staurotide*, Hornblende, *Albite*, Granite.

Calais. Granite, Marl.

Castleton. Roofing Slate (!!), Jasper, Manganese Ores, Chlorite.

Cavendish. Garnet, Serpentine (!!), Soapstone (!!) Talc (!), Actinolite, *Tremolite*, Tourmaline (!!) *Rhomb Spar*, Octahedral Iron, Asbestus, (!).

Charleston. Granite.

Chester. *Asbestus*, *Feldspar*, Chlorite, Octahedral Iron, Garnet, Kyanite, Soapstone, Talc, Actinolite, Rhomb Spar, Mica, Serpentine, Augite, Epidote, Massive Garnet, Staurotide, Tourmaline, *Quartz.*

Chittenden. Psilomelane, Pyrolusite, Brown Iron Ore, *Specular* and *Magnetic Iron*, Galena, Iolite (Thompson.)

Charlotte. Porphyry, Jasper, Graphite, Garnet and *Coccolite* (in bowlders), Green Augite.

Clarendon. Calcareous Tufa.

Colchester. Jaspery Iron Ore, Brown Hematite, Calcite, Iron Sand, Alum.

Corinth. Copper Pyrites (!!), *Iron Pyrites*, Copperas (!!), Magnetic Iron, Rutile (!), *Quartz Crystals*, Galena, *Orthoclase*, Granite, Marl.

Coventry. Rhodonite, Granite (!!), Marl (!!).

Craftsbury. Nodular Granite (!!), Calcite, Native Magnet, Rutile, Marl.

Danby. Marble (!!), Stalactites (!), Galena.

Danville. Granite, Limestone, Marl.

Derby. Granite (!), Marl (!!).

Dorset. Marble (!!), Brown Iron Ore.

Dummerston. Granite (!), Rutile, Schorl, *Roofing Slate.*

Eden. Soapstone.

Enosburgh. Specular Iron, Epidote, Soapstone, Magnetic Iron.

Fairfield. Magnetic Iron.

Fairhaven. Roofing Slate (!!), Iron Pyrites.

Fairlee. Granite.

Fletcher. Iron Pyrites, Octahedral Iron, Acicular Tourmaline, Steatite, Talc.

Franklin. Novaculite.

Glover. Granite (!), Marl.

Goshen. Manganese Ores.

Grand Isle. Marl.

Granville. Gold (!), Limestone.

Grafton. Quartz (!!), Steatite (!!), Actinolite, Serpentine, Chlorite, Rhomb Spar, Garnet, Tourmaline, Fasciculite, Talc, Kyanite, Plumose Mica.

Greensboro. Granite (!), Marl.

Groton. Granite.

Guilford. Novaculite, Scapolite, Granite, Roofing Slate (!), Brown Iron Ore, Rutile.

Halifax. Garnet, Alum, Iron Pyrites.

Hardwick. Granite, Marl (!!).

Hancock. Plumbago, *Limestone*, Chlorite.

Hartford. Calcite, Pyrites (!), Kyanite (!), Calcareous Tufa, Quartz Crystals, Tourmaline.

Highgate. Brown Iron Ore, Marl.

Hinesburgh. Limestone.

Holland. Granite, Marl (!!).

Huntington. Plumbago, Brown Iron Ore.

Irasburgh. Rhodonite, Psilomelane, Granite (!!), Wad.

Isle La Motte. Black Marble (!!).

Jamaica. *Limestone*, Dolomite, Micaceous Iron.

Jay. Chromic Iron (!), Serpentine (!), Soapstone, Picrosmine, Amianthus, Asbestus, Dolomite.

Johnson. Soapstone, *Limestone.*

Leicester. Hematite.

Lyndon. Agaric Mineral, Quartz Crystals, Mica Concretions.

Lemmington. Granite.

Lowell. Picrosmine, Amianthus, *Serpentine, Asbestus*, Wad, Brown Spar, Chlorite, Talc, Magnetic Iron, Tourmaline, Kerolite, Soapstone.

Lunenburgh. Granite.

Ludlow. Serpentine, Hornblende, Talc, Magnetic Oxyd of Iron, Chlorite.

Manchester. Brown Iron Ore.

Maidstone. Infusoria.

Marlboro. Soapstone (!), *Actinolite, Rhomb Spar, Garnet, Magnetic Iron*, Iron Pyrites, *Chlorite*, Rutile, Serpentine.

Marshfield. Granite.

Mendon. Octahedral Iron.

Milton. Red Hematite, Specular Iron, Brown Iron Ore.

Monkton. Hematite, *Pyrolusite*, Feldspar, Wad, Shell Marl (!!), Pipe Clay (!!).

Middlebury. *Dolomite*, Jasper, Tourmaline, Epidote, Honestone, Milky Quartz, Copper Pyrites, *Marble*, Zircon, Calcite, Galena, Stalactites, Stalagmites, Alabaster, Magnetic Iron.

Montpelier. Rutile, Granite, Iron Pyrites.

Middlesex. Rutile, *Serpentine.*

Moretown. Smoky Quartz (!), Soapstone (!!), Talc, Wad, *Rutile, Serpentine.*

Morgan. Granite (!!).

Morristown. Argentiferous Galena (4 oz. to ton.)

Mount Holly. *Asbestus*, Chlorite.

Newbury. Graphite (Well's River), Chlorite, Magnetic Iron, Serpentine, Granite.

Newfane. *Glassy* and *asbestiform Actinolite*, Soapstone, *Green Quartz*, Chrysoprase (?), Chalcedony, Drusy Quartz, Pyroxene, Feldspar, Tourmaline, Iron Pyrites, Alum, *Garnet, Chromic Iron, Rhomb Spar, Serpentine, Rutile, Washingtonite, Talc*, Asbestus, Pimelite.

Newport. Granite, Diallage.

Northfield. *Roofing Slate, Serpentine*, Dolomite.

North Hero. Marble (!).

Norton. Granite.

Norwich. *Actinolite*, Feldspar, Brown Spar, Talc, *Kyanite, Zoisite*, Wad, Soapstone, Rutile, Washingtonite, Magnetic Iron, Graphite, *Copper Pyrites, Iron Pyrites*, Tourmaline, Serpentine.

Orange. Granite.

Orwell. Gypsum (in soil), Flint, Calcite, Calcareous Tufa.

Panton. Marble (!!), *Limestone.*

Peacham. Kyanite, Garnets, Tourmaline, *Marl*, Infusoria, Granite.

Pittsford. *Hematite, Manganese Ores*, Plumbago, Marble.

Plainfield. Granite.

Plymouth. Gold (!), *Spathic Iron*, Magnetite, Specular Iron, Limestone (!), Hematite, Micaceous Iron, Anthophyllite, Galena, Manganese Ores.

Pomfret. Granite (!!), Wad, Iron Pyrites, Quartz, Garnets, Tourmaline.

Poultney. Wad, Roofing Slate (!!).

Pownal. *Limestone*, Pipe Clay.

Putney. Fluor, *Brown Iron Ore*, Rutile, Zoisite (in bowlders), Staurotide, Roofing Slate.

Randolph. Roofing slate (!).

Reading. Actinolite, Chlorite.

Readsboro. Hematite, *Glassy Actinolite*, Soapstone, *Limestone*, Graphite.

Richford. Heavy Spar, Soapstone, Copper Pyrites, *Limestone.*

Ripton. *Brown Iron Ore*, Augite, Octahedral Iron.

Rochester. Rutile, Specular and *Magnetic* Iron.

Rockingham. Tremolite, Stilbite, Pinite, Granite, Pyrope. (See Bellows Falls.)

Roxbury. *Dolomite, White Talc, Serpentine, Verd-antique* (!!), Asbestus, Chromic Iron, Bitter Spar, Picrosmine, Brucite (?), Gold, Actinolite, Quartz Crystals (!!) of enormous size at Middlebury College.

Royalton. Marl (!), Garnet, Hornblende.

Rutland. Marble (!!), Brown Iron Ore, Pipe Clay.

Ryegate. Mica Nodules (!!), Granite, Marl.

St. George. Brown Iron Ore.

St. Johnsbury. Marl.

Salem. Granite.

Salisbury. Hematite.

Shaftsbury. *Limestone*, Hematite.

Sharon. Kyanite, Quartz, Argillaceous Oxyd of Iron.

Shelburne. *Porphyry.*

Sherburne. Limestone, Brown Iron Ore.

Sheffield. Granite.

Shoreham. *Iron Pyrites, Black Marble*, Calcite.

Shrewsbury. Magnetic Iron, Copper Pyrites, Iron Pyrites, Smoky and Milky Quartz.

Somerset. Magnetic Iron, Native Gold, *Limestone*, Alum.

Springfield. Granite, Gold.

Starksboro. Brown Iron Ore.

Sterling. Copper Pyrites, Talc, Soapstone, Serpentine.

Stow. Soapstone.

Stockbridge. Mispickel, Steatite, Milky quartz, Epidote, Hornblende, Magnetic Iron.

Strafford. Magnetic Iron, *Copper Pyrites, Iron Pyrites*, Copperas (!), Native Copper, Hornblende, Feldspar, Hematite, Bog Ore.

Sudbury. Marble (!!).

Sutton. Granite, Marl.

Swanton. Brown Iron Ore, Mountain Leather, Marble (!).

Thetford. *Blende, Galena* (trace of silver), *Kyanite*, Quartz, Chrysolite, Roofing slate (!!), Serpentine, Novaculite, Copper Pyrites, Granite, *Soapstone, Garnet.*

Tinmouth. Hematite, Iron Pyrites.

Topsham. Rhodonite, Wad, Granite.

Townshend. *Actinolite, Black Mica, Talc, Soapstone*, Feldspar.

Troy. Magnetic Iron (!!), Talc, Serpentine (!!), Picrosmine, Amianthus, *Soapstone*, Chromic Iron, Titaniferous Iron, Novaculite, Emerald Nickel.

Tunbridge. Limestone, Marl.

Vershire. Copper Pyrites, Mispickel, Quartz, Limestone, Iron Pyrites (!!), Garnet, Fasciculite, Tourmaline, Native Copper, Malachite.

Vernon. Iron Pyrites, Andalusite, Quartz.

Victory. Granite.

Vergennes. Calcite, Quartz, *Limestone.*

Walden. Hornblende, Granite, Marl.

Wallingford. Hematite, Manganese Ores.

Waitsfield. Rutile.

Wardsboro. *Zoisite*, Tourmaline, Specular Iron, *Tremolite*, Chlorite, Quartz.

Warren. Actinolite, Magnetic Iron, Wad, Soapstone, Bog Ore, *Serpentine.*

Washington. Granite.
Waterbury. Capillary Rutile (!!), *Quartz*, Copper Pyrites, Mispickel, Soapstone, *Serpentine.*
Waterford. Mica Concretion.
Waterville. *Actinolite*, Talc, *Serpentine*, Soapstone (!!), Limestone.
West Fairlee. Granite.
Westfield. *Soapstone*, *Serpentine*, Chromic Iron.
Westminster. Zoisite (in bowlders), Marl, Scolecite (north line of town.)
Westmore. *Granite*, *Albite*, Infusoria.
Weathersfield. *Micaceous Iron*, *Limestone*, Tremolite, Iron Pyrites (!!), Steatite (!!).
Weybridge. Asbestus, Amianthus, Stalactites.
Whitingham. *Limestone*, Calcite.
Williamstown. Marl (!!), Tufa, Granite. (?)
Windham. Garnet (!!), Asbestus, Hornblende, Serpentine, Soapstone (!!), Glassy Actinolite (!!).
Windsor. Granite (!!), Syenite, Marl.
Woodbury. Massive Pyrites, Granite, Marl.
Woodstock. Garnet, *Marl*, *Zoisite*.

CATALOGUE OF THE MINERALS IN THE STATE CABINET.

1 Native Gold in quartz, Bridgewater.
2 Native Gold in quartz, Bridgewater.
3 Native Gold in quartz, Bridgewater.
4 Black Sand and Gold, Granville.
4a Black Sand and Gold, Plymouth.
5 Native Copper, Strafford.
5a Sulphur Sicily, Strafford.
6 Sulphur, Vershire.
7 Graphite in limestone (bowlder), Swanton Falls.
8 Lignite, Brandon.
9 Galena (sulphuret of lead), Bridgewater.
10 Galena, (sulphuret of lead), Bridgewater.
11 Galena (sulphuret of lead), Bridgewater.
12 Galena (sulphuret of lead), Bridgewater.
13 Galena (sulphuret of lead), Bridgewater.
14 Galena (sulphuret of lead), Bridgewater.
15 Galena with heavy spar, Morristown.
16 Galena with Blende, Bridgewater.
17 Galena with Blende, Thetford.
17a Blende (sulphuret of zinc), Thetford.
18 Blende, Galena and Quartz, Thetford.
19 Blende (sulphuret of zinc), Thetford.
20 Galena (sulphuret of lead), Thetford.
21 Galena and Quartz Crystals, Mount Tabor.
22 Chalcopyrite (copper pyrites), Strafford.
23 Chalcopyrite (copper pyrites), Strafford.
24 Chalcopyrite (copper pyrites), Strafford.
25 Chalcopyrite (copper pyrites, Hornblende,) Strafford.
26 Chalcopyrite and Iron Pyrites, Vershire.
27 Chalcopyrite in Hyaline Quartz, Vershire.
28 Chalcopyrite (copper pyrites), Corinth.
29 Chalcopyrite (copper pyrites), Corinth.
30 Chalcopyrite in Hornblende, Moretown.
31 Chalcopyrite (copper pyrites), Brighton.
32 Chalcopyrite (copper pyrites), Waterbury.
33 Chalcopyrite (copper pyrites), Brighton.
34 Pyrrhotine, Strafford.
35 Pyrrhotine, Bridgewater.
36 Pyrrhotine, White River Junction.
37 Pyrites, Strafford.
38 Mispickel, Bethel.
39 Mispickel, Bethel.
40 Pyrites, Cuttingsville.
41 Pyrites, Cuttingsville.
42 Pyrites, Waterbury.
43 Pyrites, Bethel.
44 Pyrites, Norwich.
46 Pyrites, Weathersfield.
47 Pyrites, Rochester.
48 Pyrites, South Vernon.
49 Pyrites, Shelburne.
50 Pyrites, Shelburne.
51 Molybdenite, Brighton.
52 Fluor Spar, Bellows Falls.
53 Automolite, Bridgewater.
54 Automolite, Bridgewater.
55 Automolite, Bridgewater.
56 Automolite, Bridgewater.
57 Magnetite, Norwich.
58 Magnetite, Troy.
59 Magnetite in chlorite, Cavendish.
60 Magnetite, South Troy.
61 Magnetite, South Troy.
62 Magnetite, South Troy.
63 Magnetite, South Troy.
64 Magnetite, Wolcott.
65 Chromic Iron and Serpentine, Jay.
66 Chromic Iron, Roxbury.
67 Micaceous Iron, Weathersfield.
68 Micaceous Iron, Weathersfield.

69 Specular Iron, Brandon.
70 Specular Iron, Plymouth.
71 Specular Iron, Plymouth.
72 Specular Iron (bowlder), Shelburne.
74 Lenticular argillaceous Iron, Clinton, N. Y.
75 Specular Iron (bowlder), Berkshire.
76 Ilmenite, Bethel.
77 Ilmenite, Bethel.
78 Ilmenite, Newfane.
79 Pyrolusite, Brandon.
80 Pyrolusite, Chittenden.
81 Pyrolusite, Plymouth.
82 Pyrolusite, Chittenden.
83 Pyrolusite, South Wallingford.
84 Pyrolusite with calcite (?), Chittenden.
85 Pyrolusite, Chittenden.
86 Pyrolusite, South Wallingford.
87 Pyrolusite, East Berkshire.
88 Pyrolusite, East Berkshire.
89 Pyrolusite, East Berkshire.
90 Pyrolusite, East Berkshire.
97 Rutile and Epidote, Newfane.
98 Rutile and Epidote, Newfane.
99 Rutile and Quartz, Waterbury.
100 Rutile and Quartz, Waterbury.
101 Rutile, East Corinth.
102 Limonite (brown hematite), Brandon.
103 Limonite (brown hematite), East Bennington.
104 Limonite (brown hematite), Swanton.
105 Limonite (brown hematite), Swanton.
106 Limonite (brown hematite), Chittenden.
107 Limonite (brown hematite), South Shaftsbury.
108 Limonite (brown hematite), Brandon.
109 Limonite (brown hematite), Swanton.
110 Limonite (brown hematite), Monkton.
111 Limonite (brown hematite), S. Wallingford.
112 Limonite (brown hematite), Plymouth.
113 Limonite (brown hematite), S. Wallingford.
114 Limonite (brown hematite), Brandon.
115 Limonite (brown hematite), Pittsford.
116 Limonite (brown hematite), Hartwellville.
117 Limonite (brown hematite), Colchester.
118 Limonite and Pyrolusite, Plymouth.
119 Limonite, Brandon.
120 Limonite and Calcite, Pittsford.
121 Limonite, Phillip's bed, Tinmouth.
122 Limonite, Valentine's bed, Tinmouth.
123 Limonite, Hartwellville.
124 Yellow Ochre, Wallingford.
125 Yellow Ochre, Brandon.
126 Bog Iron Ore, Strafford.
127 Bog Iron Ore, Strafford.
128 Bog Iron Ore, Strafford.
129 Bog Iron Ore, Strafford.
130 Bog Iron Ore, Strafford.
131 Wad, Warren.
132 Wad, St. Albans.
133 Wad, Highgate Springs.
134 Quartz, Mount Eolus.
135 Quartz, Mount Eolus.
136 Quartz, Mount Eolus.
137 Quartz, Mount Eolus.
138 Quartz, Waterbury.
139 Quartz, Brighton.
140 Quartz, Westford.
141 Quartz, Mount Eolus.
142 Quartz, Mount Eolus.
142 Quartz, Mount Eolus.
143 Quartz, Mount Eolus.
144 Smoky quartz, Strafford.
145 Smoky quartz, Windham.
146 Smoky quartz, Plymouth.
147 Greasy quartz, Ripton.
148 Milky quartz, Hardwick.
149 Milky Quartz, Willoughby Lake.
150 Milky Quartz, Westford.
151 Milky Quartz, Bridgewater.
152 Yellow Quartz, Royalton.
153 Drusy Quartz, Halifax.
154 Drusy Quartz, Newfane.
155 Drusy Quartz, Newfane.
156 Drusy Quartz, Newfane.
157 Mammillary Quartz, Tinmouth.
158 Crystallized Quartz, Thetford.
159 Hypersthene in red granite (bowld.), Weybridge.
160 Hypersthene in red granite (bowld.), Weybridge.
161 Hypersthene in red granite (bowld.), Weybridge.
162 Pyroxene, Fort Henry, New York.
163 Pyroxene, Fort Henry, New York.
164 Pyroxene with massive Garnet, Ft. Henry, N. Y.
165 Pyroxene with Pyrites, Fort Henry, N. Y.
166 Pyroxene with Pyrites, Fort Henry, N. Y.
167 Pyroxene (?) in Feldspar, Cavendish.
168 White Augite in limestone, Whitingham.
169 White Augite in limestone, Whitingham.
170 Hornblende, Thetford.
171 Hornblende in gneiss, Windham.
172 Hornblende in gneiss, Strafford.
173 Hornblende (fasciculite), Vershire.
174 Hornblende (fasciculite), Vershire.

175 Hornblende with Garnets, South Royalton
176 Hornblende, Grand Isle.
177 Hornblende, Grand Isle.
178 Hornblende with Garnets, Marlboro.
179 Hornblende crystalized, Townshend.
180 Hornblende (bowlder), Grand Isle.
181 Hornblende (bowlder), Grand Isle.
182 Hornblende with Pyrites, Fort Henry, N. Y.
183 Hornblende, Holland.
184 Hornblende, Holland.
185 Hornblende, Highgate.
186 Hornblende crystalized with Epidote, Chester.
187 Actinolite, Rochester, Soapstone Quarry.
188 Actinolite, Reading.
189 Actinolite crystalized in talc, Windham, Pierce's Quarry.
190 Actinolite crystalized in talc, Windham, Pierce's Quarry.
191 Actinolite, Reading.
192 Actinolite, Grafton.
193 Actinolite crystalized, Pierce's Quarry, Windham.
194 Actinolite crystalized, Rochester.
195 Actinolite, Townshend.
196 Actinolite, Rochester.
197 Anthophyllite, Plymouth.
198 Anthophyllite, Grafton.
198*a* Tremolite, Strafford.
199 Tremolite, Rochester.
200 Tremolite, Waterville, Hemenway's Quarry.
201 Actinolite, Newfane.
202 Tremolite in dolomite, Weathersfield.
203 Tremolite in dolomite, Weathersfield.
204 Raphilite (bowlder), Waterford.
205 Picrosmene, Troy.
206 Asbestus, South Troy.
207 Asbestus, Troy.
208 Asbestus, Cavendish.
209 Asbestus, Lowell, Jasper Curtis, donor.
210 Asbestus, Newport.
211 Asbestus, Troy.
212 Asbestus, Windham.
213 Asbestus in dolomite, Roxbury.
214 Asbestus in dolomite, Roxbury.
215 Asbestus, Roxbury.
216 Asbestus, Roxbury.
217 Asbestus, Roxbury.
218 Asbestus, Roxbury.
219 Amianthus, Roxbury.
220 Mountain Cork, Swanton.
221 Amianthus, Richmond.
222 Asbestus, Roxbury.
223 Amianthus in dolomite, Roxbury.
224 Asbestus, Roxbury.
225 Asbestus radiated, Roxbury.
226 Epidote in quartz, crystalized, Chester.
227 Epidote in quartz, crystalized, Chester.
228 Epidote massive, Chester.
229 Epidote in epidote rock with ilmenite, Berkshire.
230 Epidote, Berkshire.
231 Epidote, Berkshire.
232 Epidote, Berkshire.
233 Epidote, Berkshire.
234 Zoisite, Roxbury.
235 Zoisite (?), Ascutney.
236 Zoisite, Newfane.
237 Zoisite, Woodstock, Dr. Woodworth, donor.
238 Zoisite, Dummerston.
239 Zoisite, Newfane, O. L. Lincoln, donor.
240 Zoisite, Newfane, O. L. Lincoln, donor.
241 Garnets in talcose schist, Windham.
242 Garnets in talcose schist, Windham.
243 Garnets in talcose schist, Windham.
244 Garnets in talcose schist, Bethel.
245 Garnets in talcose schist, Bethel.
246 Garnets in talcose schist, Windham.
247 Garnets in talcose schist, Windham.
248 Garnets with Fasciculite, Strafford.
249 Massive Garnet, Chester.
250 Massive Garnet, Chester.
251 Pyrope in granite, Rockingham.
252 Pyrope in granite, Rockingham.
253 Colophonite in calcite, Willsboro, N. Y.
254 Chrysolite and Hornblende, Cavendish Falls.
255 Chrysolite with Hornblende (bowlder), Thetford
256 Mica, Fort Henry, N. Y.
257 Mica, Willoughby Lake.
258 Mica, Cabot.
259 Mica, Cabot.
260 Black Mica, Townshend.
261 Black Mica and Calcite, Townshend.
262 Black Mica and Calcite, Townshend.
263 Adamsite, Derby.
264 Adamsite, Glover.
265 Adamsite, Newfane.
266 Labradorite, Fort Henry, N. Y.
267 Labradorite, Fort Henry, N. Y.
268 Albite, Cabot.
269 Albite, Cabot.
270 Albite, Cabot.
271 Orthoclase and Pyrites, Corinth.

272 Orthoclase and Pyrites, Corinth.
273 Orthoclase (feldspar), Norwich.
274 Orthoclase and Actinolite, Cavendish.
275 Orthoclase, Willoughby Lake.
276 Feldspar, Bellows Falls.
277 Feldspar, Bellows Falls.
278 Kaolin, Monkton.
279 Kaolin, Brandon.
280 Lithomarge, North Dorset.
281 Lithomarge with Dendrites, North Dorset.
282 Andalusite, Bloomfield.
282½ Staurotide, Victory.
283 Staurotide in mica schist, Cavendish.
284 Kyanite, Hartford.
285 Kyanite, Thetford.
286 Kyanite, Thetford.
287 Tourmaline in white quartz, Barnet.
288 Tourmaline in white quartz, Barnet.
289 Tourmaline in white quartz, Barnet.
290 Tourmaline in white quartz, Barnet.
291 Tourmaline in white quartz, Barnet.
292 Black Tourmaline, Barnet.
293 Tourmaline, Vershire.
294 Indicolite, Bellows Falls.
295 Black Tourmaline, Cavendish.
296 Black Tourmaline, Newfane, O. L. Lincoln, donor.
297 Chlorite, Bethel.
298 Green talc, Roxbury.
299 Green talc, Bridgewater.
300 Green talc, Bridgewater.
301 Green talc, Lowell.
302 Green talc, Bridgewater.
303 Green talc, Bridgewater.
304 Green talc, Bridgewater.
305 Green talc and Dolomite, Putnam's, Windham.
306 Green talc, Newfane.
307 Green talc, Putnam's, Windham.
308 Green talc, Duxbury.
309 Soapstone, Hemenway's, Waterville.
310 Soapstone, Hemenway's, Waterville.
311 Soapstone, Bethel.
312 Picrosmine, South Troy.
313 Picrosmine, South Troy.
314 Picrosmine, South Troy.
315 Serpentine, Jay.
316 Serpentine, Jay.
317 Serpentine with talc, Jay.
318 Prehnite, Bellows Falls.
319 Prehnite, Bellows Falls.
320 Prehnite, Bellows Falls.
321 Prehnite, South Vernon.
322 Natrolite (?), Newfane.
323 Heavy spar, Richford.
324 Pimelite, Newfane.
325 Pimelite, Newfane.
326 Pimelite, Newfane.
327 Calcite, Cavendish.
328 Calcite, Bennington.
329 Calcite, Bennington.
230 Calcite, Bennington.
331 Calcite, Bennington.
332 Calcite, West Rutland.
333 Calcite, Essex.
334 Calcite, Whitingham.
335 Calcite, Roxbury.
336 Calcite, North Hero.
337 Calcite (pebble), Shelburne.
338 Salmon-colored Limestone, Townshend.
339 Red Calcite, Townshend.
340 Red Calcite, Townshend.
341 Red Limestone, Whitingham.
342 Red Limestone, Whitingham.
343 Yellowish Limestone, Townshend.
344 Greenish Limestone, Townshend.
345 White Limestone, Johnson.
346 Scarlet Calcite, Townshend.
347 Pink and white Limestone, Johnson.
348 Fetid Limestone, Isle La Motte.
349 Concretionary Calcite, Danby.
350 Stalagmitic Calcite, Danby.
351 Stalagmitic Calcite, Danby.
352 Stalagmitic Calcite, Danby.
353 Agaric mineral, Dorset Mountain.
354 Brown Spar (dolomite), Marlboro.
355 Brown Spar (dolomite), Windham.
356 Dolomite and Pyrites, South Vernon.
357 Scarlet Dolomite, Stratton.
358 Scarlet Dolomite, Weathersfield.
359 White Dolomite, Cavendish.
360 White Dolomite, Cavendish.
361 White Dolomite, Cavendish.
362 Calcite, Bridgewater.
363 Chalybite, Plymouth.
364 Chalybite, Plymouth.
365 Chalybite, Plymouth.
366 Chalybite, South Troy.
367 Chalybite, South Troy.
368 Emerald Nickel, South Troy.
369 Emerald Nickel, South Troy.
370 Green Malachite, Africa.

PART VII.

REPORT ON THE CHEMISTRY OF THE SURVEY.

BY C. H. HITCHCOCK.

As no funds were appropriated for analyses, my work has been simply to procure as many as possible from individuals who were willing to contribute a little in this important department, and to collect whatever had already been performed for the State under the superintendence of Prof. Adams. We are under great obligations to Prof. G. F. Barker, of Wheaton College, in Illinois, for his kindness in performing a variety of work for us. Mr. G. L. Goodale, of Saco, Me., has also assisted us. The analysts who performed the work for Prof. Adams were D. Olmsted, Jr. and T. S. Hunt. We have made a few analyses, so far as our limited time would permit.

ANALYSES OF MARBLES AND LIMESTONES.

1. WHITE MARBLE, FROM HYDE'S QUARRY, RUTLAND.

This was analyzed in 1846, by D. Olmsted, Jr. It is pure white and granular. Prof. Adams had supposed, with the analyst, previously to its examination, that it was magnesian. They suggested that the friableness of the marble may be due to the intermixture of grains of the silica, which is present in small quantities. The fineness of these grains and the uniformity of their diffusion, will probably prevent any difficulty arising from it to the manufacturer of it.

Carbonate of lime,	97.73
Alumina and iron,	.59
Silica and mica,	1.68
	100.00

2. GREENISH MARBLE, HYDE'S QUARRY, RUTLAND.

Analyzed by D. Olmsted, Jr., in 1846. This specimen was less friable than the preceding. There was more reason, in this case, to expect magnesia, because the green mineral was supposed to be talc. The character of this mineral, however, is yet to be determined.

Carbonate of lime,	85.45
Silica and mica,	14.55
	100.00

3. STATUARY MARBLE, BRANDON.

This is a fine, soft, white marble, a type of purity. Its analysis, by D. Olmsted, Jr., is as follows:

Carbonate of lime,	99.51
Carbonate of magnesia,	trace.
Silica, etc.,	.29
Water and loss,	.20
	100.00

4. WHITE MARBLE, MANLEY'S QUARRY, SUDBURY.

This was analyzed by T. S. Hunt, in 1847, and was said to be "a pure carbonate of lime, and, being free from magnesia and other foreign substances, will afford a superior lime for bleaching and other chemical operations."

5. .WHITE MARBLE, PHELP'S QUARRY, MIDDLEBURY.

Analyzed by T. S. Hunt, in 1847. "This is a pure carbonate of lime, like the last."

6. STATUARY MARBLE, SHELDON & SLASON'S QUARRY, WEST RUTLAND.

This was analyzed by C. H. Hitchcock, in 1857. It contained less than 12 per cent. of foreign matters; of which .57 was silica.

7. BLACK MARBLE, HILL'S QUARRY, ISLE LA MOTTE.

This was analyzed by D. Olmsted, Jr., in 1846. It belongs to the Chazy limestone period.

Carbonate of lime,	87.94
Carbonate of magnesia,	4.56
Alumina and iron,	2.60
Silica, etc.,	4.80
Water and loss,	.10
Protoxyd of manganese,	trace
	100.00

7. DOVE-COLORED MARBLE, SWANTON.

This was analyzed by D. Olmsted, Jr., in 1846.

Carbonate of lime,	94.66
Carbonate of magnesia,	.23
Alumina and iron,	1.09
Silica, etc.,	2.39
Water and loss,	1.63
	100.00

8. BRECCIATED MARBLE, PLYMOUTH.

This was analyzed by T. S. Hunt, in 1847. "It is a dolomite, containing a little protoxyd of iron and alumina. The analysis of a mixture of the colored and white portions, gave as follows:

Carbonate of lime,	53.9
Carbonate of magnesia,	44.7
Oxyds of iron and alumina,	1.3
	99.9

9. WINOOSKI MARBLE, REED'S QUARRY, COLCHESTER.

This was analyzed by C. H. Hitchcock, in 1857. The soluble portion is a dolomite.—The insoluble portion is a silicate of alumina. No examination was made for alkalies in the insoluble residue. There was not enough iron in the residue, after the removal of the silica, to color the alumina precipitate.

Silica,	10.304
Alumina and oxyd of iron,	12.251
Carbonate of lime,	35.310
Carbonate of magnesia,	42.235
	100.100

ANALYSES OF LIMESTONES.

10. LIMESTONE, NORTH DORSET.

This specimen was analyzed by D. Olmsted, Jr., in 1846. It was taken from the vicinity of the curious dike of lithomarge, upon the land of Daniel Curtis. It is compact, with a brownish tinge, and argillaceous odor.

Carbonate of lime,	85.18
Carbonate of magnesia,	13.11
Alumina and oxyd of iron,	1.79
Silica, etc.,	1.49
	101.57

This is magnesian, but not a dolomite.

11. LIMESTONE, BRISTOL.

This was analyzed by D. Olmsted, Jr., in 1846. It was taken from close proximity to the hematite beds. Its physical characters are the same as the preceding.

Carbonate of lime,	51.35
Carbonate of magnesia,	44.76
Alumina and iron,	2.00
Silica, etc.,	1.40
Water and loss,	.49
	100.00

This is doubtless a true dolomite.

12. LIMESTONE, MILTON.

This was analyzed by D. Olmsted, Jr., in 1846. It was taken from the northwest corner of Milton, from a rock containing specular iron, and belonging to the red sandstone formation — like the Winooski marble. This is shown to be a magnesian limestone.

Carbonate of lime,	84.45
Carbonate of magnesia,	12.14
Alumina and iron,	1.01
Silica, etc.,	1.50
Water and loss,	.90
	100.00

13. BRECCIATED DOVE-COLORED LIMESTONE, BRISTOL.

This was analyzed by T. S. Hunt, in 1847. It was proved to be a "dolomite, containing grains of silica and small portions of alumina and oxyd of iron." Analysis gives:

Carbonate of lime,	51.7
Carbonate of magnesia,	40.6
Oxyd of iron and alumina,	3.8
Silica,	3.9
	100.00

14. GRAYISH-WHITE LIMESTONE, PLYMOUTH.

This was analyzed by T. S. Hunt, in 1847. "It is a dolomite with traces of iron."

15. WATER LIMESTONE, SHELBURNE.

This was analyzed by T. S. Hunt, in 1848.

Carbonate of lime,	48.85
Carbonate of magnesia,	36.84
Silica colored by carbonaceous matter,	11.40
Peroxyd of iron, } Traces of alumina, }	2.65
Water,	.70
	100.44

This is evidently a dolomite; but we should doubt whether it would afford a good material for water lime.

16. WHITISH LIMESTONE, FRANKLIN.

This was analyzed by C. H. Hitchcock, in 1858. It was thought, when the specimen was obtained in the field, that it might answer for a lithographic stone. We have been unable to compare with it the analysis of any stone of this description. It belongs to the group of talcose conglomerates, and is a dolomite with considerable insoluble matter.—The substances (if any) besides silica in the latter portion, were not determined.

Silica etc.,	30.419
Peroxyd of iron and alumina,	2.331
Carbonate of lime,	35.419
Carbonate of magnesia,	31.831
	100.000

17. YELLOWISH LIMESTONE, BRANDON.

This was analyzed by G. F. Barker, in 1859. It was taken from the vicinity of the iron mines; and is perhaps the source of the hematite. We refer to his Report for the details.

18. WHITE LIMESTONE, HARDY'S QUARRY, BAKERSFIELD.

This was analyzed by T. S. Hunt, in 1847. Granular. This limestone contains a small quantity of carbonate of magnesia, and a portion of silica disseminated in grains through the mass. Analysis gives for its composition,

Carbonate of lime,	92.9
Carbonate of magnesia,	5.5
Silica,	1.6
	100.0

19. WHITE LIMESTONE, WEBBER'S QUARRY, CAVENDISH.

This was analyzed by T. S. Hunt, in 1847. "Granular, feebly coherent. This is a proper *dolomite*, containing carbonate of lime and carbonate of magnesia in the proportion of one equivalent of each. It contains disseminated grains of silica. Analysis gives the following result:

Carbonate of lime,	53.8
Carbonate of magnesia,	43.3
Silica,	2.9
	100.0

20. GRAYISH-WHITE LIMESTONE, HANCOCK.

This was analyzed by T. S. Hunt, in 1847. "This contains a small portion of carbonate of magnesia, silica in grains, and a trace of oxyd of iron." Its analysis gives the annexed result:

Carbonate of lime,	90.3
Carbonate of magnesia,	6.9
Oxyd of iron,	a trace.
Silica,	2.8
	100.0

21. DOLOMITE, STRATTON.

This was analyzed by G. F. Barker, in 1859. See his Report.

22. WHITE LIMESTONE, WHITINGHAM.

This was analyzed by C. H. Hitchcock, in 1857. It is from J. Kentfield's quarry, in the west part of the town, and is used entirely for the manufacture of lime. It is highly crystalline, and of a milk-white color. It contains:

Carbonate of lime,	97.5
Carbonate of magnesia,	2.1
Alumina and oxyd of iron,	.2
Silica (by difference),	.2
	100.0

Thus it is seen to be a very pure carbonate of lime.

23. GRANULAR LIMESTONE, GRANVILLE.

This was analyzed by C. H. Hitchcock, in 1857. It is upon the farm of William C. Chaffee, in the north part of the town, and has been used only for the manufacture of lime. Part is white and part is of a dark-brown color. The latter is probably owing to the presence of carbon. It contains

Carbonate of lime,	89.741
Carbonate of magnesia,	4.264
Oxyd of iron and alumina,	2.420
Silica and carbon,	4.875
	101.300

This is from the (so called) talcose schist.

The seven analyses following are specimens of the impure limestone associated with the calciferous mica schist formation.

24. LIMESTONE, CRAFTSBURY.

This silicious limestone was analyzed by D. Olmsted, Jr., in 1846.

Carbonate of lime,	30.82
Carbonate of magnesia,	2.51
Alumina and iron,	2.05
Silica, etc.,	60.00
Water and loss,	4.62
	100.00

25. LIMESTONE, HARDWICK.

This was analyzed by D. Olmsted, Jr., in 1846.

Carbonate of lime,	52.47
Carbonate of magnesia,	3.72
Alumina and iron,	3.00
Silica, etc.,	39.90
Water and loss,	.91
	100.00

26. LIMESTONE, DANVILLE.

This was analyzed by D. Olmsted, Jr., in 1846.

Carbonate of lime,	53.50
Carbonate of magnesia,	2.20
Alumnia and iron,	1.90
Silica, etc.,	38.90
Water and loss,	3.50
	100.00

27. LIMESTONE, BARNET.

This was analyzed by D. Olmsted, Jr., in 1846.

Carbonate of lime,	47.07
Carbonate of magnesia,	4.00
Alumina and iron,	1.70
Protoxyd of manganese,	trace.
Silica, etc..	44.70
Water and loss,	2.53
	100.00

28. LIMESTONE, VERSHIRE.

This was analyzed by D. Olmsted, Jr., in 1846.

Carbonate of lime,	36.78
Carbonate of magnesia,	3.27
Alumina and iron,	8.80
Silica, etc.,	50.15
Water and loss,	1.00
	100.00

29. SILICIOUS LIMESTONE, TUNBRIDGE.

This was analyzed by T. S. Hunt, in 1847. Like the others, this specimen was of a dark, bluish-gray color. "It contains a large quantity of matter insoluble in acids, principally silica." The results of its analysis give, for its composition,

Carbonate of lime,	37.8
Carbonate of magnesia,	3.2
Oxyd of iron and alumina,	2.7
Insoluble silicious matter,	55.9
	99.6

30. SILICIOUS LIMESTONE, GROTON.

This was analyzed by C. H. Hitchcock, in 1857.

Carbonate of lime,	63.12
Carbonate of magnesia,	trace.
Insoluble silicious matter,	35.28
Oxyd of iron and alumina,	1.89
	100.29

31. MARBLE, SUDBURY.

The following analysis was made for the proprietors of the Sudbury Marble Co., by Dr. A. A. Hayes, of Boston. We obtained it at the quarry:

Carbonate of lime,	99.70
Carbonate of magnesia and peroxyd of iron,	.30
	100.00

This, then, is an unusually pure limestone.

32. LIMESTONE, HAVERHILL, N. H.

Analyzed by Dr. C. T. Jackson, in the N. H. Report. It is in the talcose schist formation, and as there have been no analyses made of any Vermont limestones in this formation, I have thought it desirable to quote the following:

Carbonate of lime,	99.3
Silica and mica,	.5
Carbonate of the protoxyd of manganese,	.2
	100.00

33. LIMESTONE, LUNENBURGH.

This was analyzed by J. D. Whitney, in the N. H. Report, and probably belongs to this same talcose schist.

Silica,	40.6
Carbonate of lime, } Carbonate of magnesia, }	47.6
Oxyd of iron and alumina,	11.0
	99.2

34. LIMESTONE, RICH'S QUARRY, SWANTON.

This was analyzed by Count Majeroski, of Plattsburgh, N. Y.; communicated to us at the quarry.

Carbonate of lime,	70.00
Silica and alumina,	28.00
Iron and magnesia,	2.00
	100.00

ANALYSES OF MARLS, CLAYSTONES, CLAYS, ETC.

Four specimens of marl from different locations, were analyzed in 1847 by T. S. Hunt. "The marls are, as usual, carbonate of lime, with a little magnesia and earthy matter.— In the analysis I separated, as much as possible, the shells and fibers from the marl.

"As many marls are said to contain phosphate of lime, which greatly enhances their value as fertilizers of the soil, particular reference was had to its detection in the analyses; but the results showed that phosphates, if present, exist in so small a proportion as not to be detected in operating on the quantity of marl submitted to analysis. The results are as follows:

35. MARL, ALBURGH.

Carbonate of lime,	82.6
Carbonate of magnesia,	2.5
Silica and traces of oxyd of iron and alumina,	2.6
Water and a little vegetable matter,	12.3
	100.0

36. MARL, WILLIAMSTOWN.

Carbonate of lime,	89.0
Carbonate of magnesia,	4.2
Silica with traces of oxyd of iron and alumina,	1.0
Water and a little organic matter,	5.5
	99.7

37. MARL, PEACHAM.

Carbonate of lime,	83.5
Carbonate of magnesia,	1.0
Silica and traces of oxyd of iron and alumina,	4.2
Water and vegetable matter,	10.5
	99.2

38. MARL, MONKTON.

This has a different geological formation underlying it; and it contains more earthy and organic matters than the others.

Carbonate of lime,	72.9
Carbonate of magnesia,	2.4
Silica with a little oxyd of iron and alumina,	11.2
Water and vegetable matter,	13.6
	100.1

ANALYSES OF CLAYSTONES.

The first seven analyses were performed by D. Olmsted, Jr., in 1846.

39. CLAYSTONE, DUMMERSTON.

Carbonate of lime,	51.08
Carbonate of magnesia,	5.40
Alumina,	28.40
Peroxyd of iron,	8.12
Protoxyd of manganese,	1.50
Silica,	8.08
	102.58

40. CLAYSTONE, ADDISON.

Carbonate of lime,	45.09
Carbonate of magnesia,	17.34
Alumina,	21.13
Peroxyd of iron,	1.73
Protoxyd of manganese,	.60
Silica,	16.18
	102.07

41. CLAYSTONE, ALBURGH.

Carbonate of lime,	53.17
Carbonate of magnesia,	2.48
Alumina,	20.95
Peroxyd of iron,	6.76
Protoxyd of manganese,	1.50
Silica,	12.40
Water,	3.48
	100.74

42. CLAYSTONE, PITTSFORD.

Carbonate of lime,	42.88
Carbonate of magnesia,	3.76
Alumina,	19.10
Peroxyd of iron,	8.81
Protoxyd of manganese,	trace
Silica,	25.29
	100.54

43. CLAYSTONE, DERBY.

Carbonate of lime,	49.66
Carbonate of magnesia,	1.59
Alumina,	12.60
Peroxyd of iron,	8.68
Protoxyd of manganese,	2.00
Silica,	16.18
Water,	9.32
	100.00

44. CLAYSTONE, SHELBURNE.

Carbonate of lime,	52.58
Carbonate of magnesia,	5.31
Alumina,	7.30
Peroxyd of iron,	3.02
Protoxyd of manganese,	1.38
Silica,	28.70
Water,	1.71
	100.00

45. CLAYSTONE, NORWICH.

Carbonate of lime,	44.84
Carbonate of magnesia,	3.26
Alumina,	8.50
Peroxyd of iron,	5.32
Protoxyd of manganese,	4.47
Silica,	29.08
Water,	4.53
	100.00

Seven other specimens of claystones were analyzed by T. S. Hunt, in 1847. We give them, and his remarks upon them.

"*Claystones.* The examination of these concretions shows that they consist of carbonate of lime, mechanically involving a somewhat variable amount of clay and silicious matter. A dilute acid readily dissolves the earthy carbonate and leaves the clay unaffected. A small portion of carbonate of magnesia appears to be always present, and the clay contains, in addition to silica and alumina, a small and variable proportion of oxyd of iron, besides traces of oxyd of manganese. The presence of this last ingredient was always indicated by the green tint due to manganate of soda, which appeared when the clay was fused with an alkaline carbonate, but its quantity was very minute. The separation of the iron and alumina was not attempted, as it appeared a matter of little consequence.

46. ARGILLO-CALCAREOUS CLAYSTONE, RYEGATE.

Carbonate of lime,	40.2	42.9
Carbonate of magnesia,	2.7	
Alumina and oxyd of iron,	42.3	56.0
Silica,	13.7	
	98.9	

47. CLAYSTONE, BETHEL.

Carbonate of lime,	40.9	42.0
Carbonate of magnesia,	1.1	
Alumina and oxyd of iron,	41.7	56.9
Silica,	15.2	
	98.9	

48. CLAYSTONE, PITTSFORD.

Carbonate of lime,	44.3	48.3
Carbonate of magnesia,	4.0	
Alumina and oxyd of iron,	36.3	51.6
Silica,	15.3	
	99.9	

49. CLAYSTONE, RUTLAND.

Carbonate of lime,	44.4	49.3
Carbonate of magnesia,	4.9	
Alumina and oxyd of iron,	32.9	49.7
Silica,	16.8	
	99.0	

50. CLAYSTONE, NORWICH.

Carbonate of lime,	40.8	48.0
Carbonate of magnesia,	7.2	
Alumina and oxyd of iron,	35.5	52.8
Silica,	17.3	
	100.8	

51. CLAYSTONE, SHARON.

Carbonate of lime,	43.3	45.1
Carbonate of magnesia,	1.8	
Alumina and oxyd of iron,	33.2	49.8
Silica,	16.6	
Loss—water,	5.1	
	100.00	

52. CLAYSTONE, RYEGATE.

Carbonate of lime,	35.8
Carbonate of magnesia,	traces.
Coarse sand and clay,	64.2
	100.0

This is an example of a calcareous concretion, embracing sand and coarse earth. The insoluble residue was not submitted to analysis."

ANALYSES OF CLAYS, ETC.

53. BROWN CLAY, MIDDLEBURY.

This was analyzed by T. S. Hunt, in 1847, and its constituents given as follows:

Alumina,	31.2
Silica,	49.7
Iron and traces of manganese,	6.6
Water,	12.3
	99.8

Prof. Adams added in a note that carbonate of lime was also present; and upon re-examination Mr. Hunt found of

Carbonate of lime,	3.97 per cent.
Carbonate of magnesia,	2.30 per cent.

This belongs to the Champlain clays.

54. PIPE CLAY, BENNINGTON.

This specimen was analyzed by D. Olmsted, Jr., in 1846. In consequence of his poor health, he was unable to determine how much of the alumina was free, and how much was combined with silica, or in whatever other form it might exist. The three first analyses of this pipe clay are of little value, except in their determination of the whole percentage of the different bases.

Silica,	18.20
Alumina,	65.60
Magnesia,	3.24
Water,	13.20
	100.24

About thirteen per cent. of this alumina is in an uncombined state.

55. PIPE CLAY, WALLINGFORD.

This was analyzed by T. S. Hunt, in 1848. It burns quite white.

Silica,	48.33
Alumina,	37.25
Oxyd of iron,	.23
Water,	13.30
	99.11

56. PIPE CLAY, WALLINGFORD.

This was analyzed by T. S. Hunt, in 1848. "The specimen was from a disintegrated stratum of silico-calcareous rock. It whitens in the fire."

Silica,	50.30
Alumina,	34.10
Oxyd of iron,	3.25
Lime, Traces of magnesia,	3.47
Water,	9.40
	100.52

57. FELDSPATHIC ROCK, MONKTON.

This was obtained from the central part of the white clay bed in this town, and was examined under the direction of Prof. Thompson.

Silica,	96.13
Alumina and iron,	2.18
Lime,	.71
Potassa and loss,	.98 (?)
	100.00

58. INFUSORIAL SILICA, PEACHAM.

This was analyzed by T. S. Hunt, in 1847. It consists almost entirely of silica. It contains, however, traces of carbonate of lime. Query: Is the latter from infusorial shields of the calcareous carbonate?

59. INFUSORIAL EARTH, MAIDSTONE.

This was examined by T. S. Hunt, in 1847. "Like the last, silica with small portions of carbonate of lime and vegetable matter."

Oxyd of iron,	3.25
Lime, Traces of magnesia,	3.47
Water,	9.40

The lime exists here as a silicate, at least in such a state as to be insoluble in acids.

60. AN INCRUSTATION, HUNTINGTON.

This was examined by D. Olmsted, Jr., in 1846. "It was found to consist of a soluble and an insoluble portion. The soluble portion consisted chiefly of sulphate of lime, with a mere trace of sulphate of iron. No alumina was detected in the soluble portion.

ANALYSES OF ORES. IRON ORES.

The following thirteen analyses were performed by D. Olmsted, Jr., in 1846.

61. "BLACK ORE," WALLINGFORD.

Peroxyd of iron,	71.30
Peroxyd of manganese,	12.93
Alumina,	trace.
Silica,	3.00
Water,	12.50
	99.73
Metallic iron,	49.34

62. "ALLOY," WALLINGFORD.

Metallic iron,	88.71
Metallic manganese,	11.28
	99.99

63. IRON ORE, FROM CHITTENDEN.

	Solid ore bed.	*Silicious ore.*
Peroxyd of iron,	84.90	37.81
Alumina,	.47	trace.
Silica,	.75	55.81
Water,	13.88	6.38
	100.00	100.00
Metallic iron,	58.66	26.84

64. COLCHESTER ORE.

Peroxyd of iron,	91.50
Water,	11.32
	100.00
Metallic iron	61.00

65. MAGNETIC IRON ORE, TROY.

Peroxyd of iron,	81.20
Protoxyd of iron,	13.37
Titanic acid,	4.10
Silica,	1.33
	100.00
Metallic iron,	66.62

66. IRON ORES, FROM PLYMOUTH.

There are three varieties of them in this town: crystals of magnetite imbedded in the second variety, a gangue of silicious specular ore, and specular ore.

	Crystals.	*Gangue.*	*Specular ore.*
Peroxyd of iron,	73.82	15.00	99.89
Protoxyd of iron,	26.18		
Silica,	trace.	76.00	trace.
Water,		9.00	
	100.00	100.00	99.89
Metallic iron,	72.03	10.40	69.26

67. MAGNETIC IRON ORE, MILTON.

Two specimens of this ore were analyzed.

Peroxyd of iron,	98.30	98.22
Protoxyd of iron,	.97	
Peroxyd of manganese,	trace.	
Silica,	.91	1.78
	100.18	100.00
Metallic iron,	69.00	68.10

68. MAGNETIC IRON ORE, FAIRFIELD.

Peroxyd of iron,	95.71
Protoxyd of iron,	trace.
Silica,	3.91
	99.62
Metallic iron,	66.36

69. SPECULAR IRON ORE, BERKSHIRE.

This specimen is a talcose rock, through which are abundantly disseminated particles of specular ore.

Peroxyd of iron,	44.01
Insoluble residue,	46.39
Lime, magnesia and loss,	9.60
	100.00
Metallic iron,	28.27

70. BROWN IRON ORE, TYSON'S FURNACE, PLYMOUTH.

This was analyzed by T. S. Hunt, in 1848.

Peroxyd of iron,	83.03
Silica,	2.53
Water,	14.50
	100.06
Metallic iron,	58.12

71. CHROMIC IRON, JAY.

This was analyzed by T. S. Hunt, in 1847.

Green oxyd of chromium,	49.90
Protoxyd of iron,	48.96
Alumina with traces of silica and magnesia (by the loss.)	4.14
	103.00

One hundred parts of this ore yield of neutral chromate of lead (pure chrome yellow), 191.2 parts.

72. COPPER PYRITES, CORINTH.

This was analyzed by D. Olmsted, Jr., in 1846. It was from a vein eighteen inches wide, in iron pyrites twenty feet wide.

Copper,	27.28
Iron,	37.91
Sulphur,	33.70
Silica and mica,	1.11
	100.00

73. We find among the papers left by Prof. Thompson, another analysis of this mineral. "Pieces of the copper pyrites, of a fine yellow color, were carefully selected, and analyzed with the following result:

Sulphur,	33.00
Copper,	34.80
Iron,	31.12
Silica,	2.05
	100.97

Thus corresponding very nearly with the calculated formula for this mineral.

74. A specimen of ore that was picked up in Corinth by Mr. J. B. Stevens, of East Corinth, was found, by C. H. Hitchcock, to contain sulphur, copper, nickel and arsenic in

large quantities, with a trace of lime. The specimen was probably removed from its original position by drift.

75. MAGNETIC IRON ORE, JUDGE YOUNG'S BED, SOUTH TROY.

This was analyzed by C. H. Hitchcock, in 1858.

Peroxyd of iron,	72.46
Protoxyd of iron,	25.90
Silica and titanic acid (by diff.),	1.64
	100.00

This was a selected specimen, and hence is superior in quality to the average. In another specimen from the same bed, we found magnesia and a trace of lime.

MISCELLANEOUS ORES.

76. PSILOMELANE, CONANT'S BED, BRANDON.

This was analyzed by D. Olmsted, Jr., in 1846.

Red oxyd of manganese,	81.38
Oxygen,	2.74
Magnesia,	2.22
Silica,	3.60
Water,	9.75
	99.69
Metallic manganese,	58.755
Oxygen,	25.365

Which is remarkably pure.

77. At the copperas works, at Strafford, we were told by the Agent that A. A. Hayes, of Boston, had examined several specimens of their ore for copper, and had found in them respectively 6.55, 6.17, 5.40, 6.40, and 10.60 per centum of metallic copper. "This was an average of the copper shipped from Strafford at different times." A. D. H.

78. GALENA, MORRISTOWN.

This was analyzed by T. S. Hunt, in 1847. "A portion of lead reduced from this ore gave a small quantity of silver by cupellation. It was equal to one-fifth of one per centum, which is four pounds of silver to the ton (2000 lbs.) of metal. This quantity will be well worth working, provided the lead is abundant. An assay on another portion of the ore, embracing fragments from several specimens, to afford an average, will be very desirable, as the general proportion of silver may be greater or less than that afforded by the specimen examined. Probably one pound of silver in a ton of lead would more than repay the cost of extraction, as lead yielding only four ounces to the ton is said to be profitably cupelled in Great Britain."

"These estimates refer only to the extraction of the silver, not to the cost of the ore, which must be paid for by the lead obtained." C. B. A.

Mr. Olmsted found traces of silver in the galena of Thetford.

79. GALENA, BRIDGEWATER.

Specimens from the Cunningham gold vein were examined by Prof. J. W. Mallett, State Chemist of Alabama, and were found to contain 25 oz. av. of silver to every ton of its own weight. This would be profitable, provided there was a plenty of galena. As mentioned elsewhere, however, the quantity of galena is very scanty.

REPORT OF PROF. G. F. BARKER.

"The rocks placed in my hands for analysis have been carefully examined, and I have pleasure in now presenting the results. Of course the geological bearings of these examinations cannot enter into this Report, for the localities are unknown to me, never having visited them. What is found here is simply the facts of interest, physical and chemical, of the rocks themselves.

Through the kindness of Dr. John Bacon, of Boston, these analyses were made in the Medical College Laboratory. The course pursued was the usual one for the analysis of silicates in the cases where the rocks were such. Fluxing with carbonate of soda for all but the alkalies, and determining *these* by means of Dr. Smith's method with carbonate of lime and chloride ammonium: the alumina and iron were determined together, in every case being dissolved and re-precipitated to insure their freedom from the alkaline earths; this precipitation was effected by gaseous ammonia; the dolomites were dissolved in the apparatus for carbonic acid, which thus was determined by loss of weight; the lime and magnesia were determined after removal of the residue not soluble, and the alumina and iron, as oxalate and triple phosphate; an attempt was made to separate these by sulphuric acid and alcohol, which was not satisfactory, the sulphate of magnesia being nearly as insoluble as sulphate of lime. To turn now to the rocks themselves.

I. (80) The first is a clear white, finely granular, friable dolomite, from Somerset; on this four complete determinations were made. The following is the mean:

Carbonate of lime,	65.41
Carbonate of magnesia,	30.05
Carbonate of the protoxyd of iron,	1.61
Insoluble matters,	2.58
	99.65

Concerning this it was remarked by the quarrymen that when burned, it became dark-colored; this is owing to the expulsion of the carbonic acid from the iron by the heat, when the protoxyd abstracts oxygen from the air and passes into peroxyd, darkening the mass. It will be seen that this is not a true dolomite, but only a magnesian limestone, in which the proportions of the carbonates are as 3 to 2; the proportion for the true dolomite is 1 to 1. The residue left after the solution of this mineral in acid, is in the form of white, glistening scales, presenting a singular appearance.

II. (81) The next is a hard, compact, dark-red sandrock, from Charlotte; the specific gravity of it is 2.65; on ignition it changed color, becoming darker; the analysis gave as follows:

Silica,	83.30
Alumina and iron,	8.70
Lime,	1.12
Magnesia,	.10
Potassa,	4.59
Soda,	.45
Loss by ignition,	.80
	99.06

This excess of silica is due to sand present; it could not be separated as the mineral is not acted on by acids; the oxygen ratio of the basis is 1 : 3.

III. (82) Feldspar in granite, from Stamford. The crystals being small, it was with some difficulty enough could be procured for analysis; this resulted as follows:

			Oxygen.
Silica,	64.00		34.00
Alumina,	20.40		9.25
Lime,	1.79	.51	
Magnesia,	traces.		3.04
Potassa,	9.75	1.66	
Soda,	3.37	.87	
Loss by ignition,	.20		
	99.51		

Giving the oxygen ratio 1 : 3 : 12, and the formula ($RO, SiO_3+Al_2O_3 3SiO_3$); it is therefore an orthoclase, a part of the potassa being replaced by soda; its color is a dirty white, translucent.

IV. (83) Trachytic trap (so called) from Shelburne. The rock is yellowish-gray, with a rough fracture. Specific gravity 2.60. Analyzed with the following results:

			Oxygen.
Silica,	67.30		35.65
Alumina and iron,	19.10		8.91
Lime,	.79	.23	
Magnesia,	traces.		2.60
Potassa,	4.74	.81	
Soda,	6.04	1.56	
Loss by ignition,	1.70		
	99.67		

This gives the oxygen ratio 1 : 3 : 12 or that of feldspar. The excess of silica is due to quartz present in the mineral. Sulphydric acid gas was evolved on treating the fusion with chlorohydric acid.

V. (84) Mineral from Bridgewater, soapstone bed. Determined it qualitatively to be brown spar, colored by carbonate of manganese.

VI. (85) Amphibole; too much weathered to make analysis of.

VII. (86) Rock supposed to contain gold: examined it qualitatively; results negative; contains yellow mica in small scales; the mass of the rock is the magnetic oxyd of iron.

VIII. (87) Talcose slate (so called) Roxbury. This rock is schistose, friable, of a greenish-gray color; fissile; spec. gravity 2.72. The analysis gave the following result:

Silica,	69.90
Alumina and iron,	20.00
Lime,	1.51
Magnesia,	1.80
Soda,	2.33
Potassa,	1.45
Loss by ignition,	2.40
	99.39

From this analysis it will appear evident that the name "talcose," applied to these rocks, is a misnomer. There can be neither talc or chlorite in them, for both these contain from thirty-two to thirty-six per cent. of magnesia. Mr. T. S. Hunt, in his report on them in Canada, proposes the name, "nacreous slates," from their luster. The small proportion of water in this rock would seem to indicate some other mineral than pyrophyllite; and the total absence of any exfoliation under the blow-pipe, would tend to confirm this impression.

IX. (88) This is another slate of the same general character as the preceding; it comes from Pownal, and its color is a bluish-gray; not as friable as the last, while its feel is more unctuous. On dissolving the fusion with carbonate of soda in hydrochloric acid, hydrosulphuric acid gas was evolved, which blackened a solution of acetate of lead; yet the mineral, treated with strong nitric acid, and boiled, gave no reaction for sulphuric acid, as would be the case were sulphurets present. The analysis gave the following composition:

			Oxygen.
Silica,	42.90		22.73
Alumina and iron,	42.20		19.71
Lime,	.78	.22	
Magnesia,	1.98	.79	
Potassa,	5.24	.89	7.22
Soda,	1.33	.34	
Loss on ignition,	5.60	4.98	
	100.03		

That this is a distinct rock from the last is shown by the differences in the silica and alumina. Its specific gravity is greater, being 2.90; the magnesia remains nearly the same; while the alkalies are nearly doubled, as is also the water. An analysis of talcite (Dana's Min., 4th ed., p. 509), by Tennant, strikingly agrees with this in composition. The specimen he used was from Wicklow, Ireland. The oxygen ratios here will be seen to be nearly 1 : 3 : 3 : (that is, 1 : 2.7 : 3.14) : giving the formula $(RO_1R_2O_3)$ SiO_3. This is said to belong to Emmons' Taconic (magnesian) slates.

X. (89) This is, again, one of the so-called talcose slates; perhaps more properly talcoid. It comes from Middlesex; is less schistose and more slaty than the last; color, olive-green; argillaceous odor. Its analysis gave as follows:

Silica,	64.10
Alumina and iron,	23.50
Lime,	.84
Magnesia,	1.98
Potassa,	3.70
Soda,	2.20
Loss by ignition,	3.60
	99.92

This resembles more closely No. 8, in its composition, the silica being a little less and the alumina greater than in that rock. The proportion of the composing mineral varies, being mixed with extraneous matters. Scattered through it are octahedral crystals of magnetic oxyd of iron. These were carefully removed with the magnet from the portion

of the mineral submitted to analysis. The presence of these rendered the determination of the specific gravity inaccurate. It is less friable than No. 8, and has more tenacity. Before the blow-pipe it is unaltered. A thin sliver was softened on the edges, however.

XI. (90) A mineral from Irasburgh, called novaculite. Very homogeneous in composition; fracture rough; structure amorphous. It is translucent; of a dirty-gray color: streak white. Specific gravity 2.65. A careful analysis gave the composition,

			Oxygen.
Silica,	78.70		41.69
Alumina (trace iron),	12.80		5.97
Lime,	1.23	.35	
Magnesia,	traces.		1.94
Potassa,	.89	.15	
Soda,	5.57	1.44	
Loss on ignition,	.60		
	99.79		

This would make the oxygen ratio 1 : 3 : 21 or (RO,R_2O_3) $7SiO_3$. Though called a talcose slate, like the three preceding its physical and chemical characters are widely different. Of magnesia there is but a trace, and the loss by ignition is small. Before the blow-pipe it becomes white and opaque; is infusible and colors the flame yellow. With cobalt solution it gives a fine blue.

XII. (91) Yellowish limestone, from Brandon. It is harder than No. 1, and somewhat crystalline. Color dirty yellowish-brown. The results of the analysis were as follows:

Carbonate of lime,	40.88
Carbonate of magnesia,	51.40
Carbonate of iron,	3.67
Quartz and insoluble matters,	3.44
	99.39

The iron here is calculated as carbonate, because the excess of the carbonic acid (given by two determinations 46.00, 45.81) requires us to suppose a part of it so exists. From the color of the rock it is evident a part of the iron exists as peroxyd. The magnesian carbonate seems to be in excess, a fact noticed early in the investigation, from the feeble effervescence with chlorohydric acid; but the proportions are such between them as to prove no chemical union, but only a mixture."

EXAMINATION OF MINERALS.

92. A specimen of a light-green mineral, from Plymouth, was found by T. S. Hunt to be pulverulent *green malachite*, or carbonate of copper. Small brown or purple particles associated with them were *vitreous copper*. The inclosing rock is dolomite.

93. The *chalybite*, or spathic iron, from Plymouth, was examined by us, and was found to be mixed with more or less of pyrites. There was no phosphoric acid detected, but there was a small per cent. of manganese discovered. See p. 143 of Thompson's Mineralogy.

According to T. G. Clemson, this chalybite contains

Carbonate of protoxyd of iron,	74.28
Carbonate of magnesia,	16.40
Carbonate of protoxyd of manganese,	6.56
Peroxyd of iron,	.30
Silica, etc.,	1.40
	98.94

94. The *zinc blende*, from Bridgewater, was found by us to contain four per cent. of cadmium. We have also determined by chemistry the characters of many minerals, the particulars of which it is unnecessary to mention.

Prof. C. U. Shepard, of Amherst College, has determined for us the species of many of the minerals of Vermont; and among them he has given an approximate analysis of the lithomarge from North Dorset, which is as follows:

95. It is principally a hydrated silicate of alumina, containing three or four per cent. of carbonate of lime, and 19.33 per cent. of water, of which Prof. Brush, of Yale College, says that only thirteen per cent. is in chemical combination. Before the blow-pipe it becomes white, and fuses into a blebby transparent glass.

96. In the mineralogical report there is given a description of a new species of the mica family, *Adamsite*. Prof. Brush has given an approximate analysis of it, as follows:

Silica,	47.76
Alumina with peroxyd of iron (3 or 4 per cent.(?)	39.29
Lime,	.24
Magnesia,	1.85
Alkalies (by loss),	8.77
Volatile matter,	5.09
	100.00

Prof. Shepard remarked, in connection with this analysis, that nothing had been made out from it incompatible with its belonging to the micas, but that, in consequence of the impurity of the specimen examined, a new analysis is desirable.

The following notes are taken from examinations made under the direction of Prof. Z. Thompson.

97. IRON PYRITES, BRIGHTON.

This specimen was taken from a vein several feet wide, near the residence of Dr. Coe. It was much tarnished, and resembled copper pyrites.

Insoluble matter resembling chlorite,	58.79
Sulphur,	18.22
Iron,	24.63
	101.64

The mineral slightly attracted the magnet, which circumstance, with the result of the analysis, show it to be the *magnetic iron pyrites*.

98. CHRYSOPRASE, NEWFANE.

"A green mineral from Newfane, supposed to be chrysoprase, was found to contain a small amount of *nickel*, and is rightly named."

99. DOLOMITE, CHITTENDEN.

"A crystalline mass from Chittenden was found to be nearly soluble in hydrochloric acid, with the exception of a small residuum of silica. The solution was found to contain lime and magnesia, carbonic acid having previously escaped. It is, therefore, a magnesian limestone."

100. BLENDE, BRIDGEWATER.

"Before the blow-pipe it gives the reaction for iron, with borax and phosphate of soda. Heated with carbonate of soda on charcoal, the latter is coated with a yellow ring of oxyd of zinc, and immediately around the mixture with brown oxyd of cadmium. Heated with a mixture of cyanid of potassium and soda, or coal, metallic globules of cadmium are obtained. Its composition is

Zinc,	56.12
Iron,	8.54
Cadmium,	2.50
Sulphur,	32.80
Manganese,	trace.
Copper,	trace.
	99.96

MINERAL WATERS.

We can present little of value upon this topic. There are several valuable mineral waters in the State, as at Panton, Highgate, Clarendon, Williamstown, etc., etc., but we had no funds to appropriate for their examination, much to our regret. We have the qualitative analyses of three of them, which are worth preserving in the absence of anything more reliable.

97. Dr. C. Linnæus Allen qualitatively analyzed the water of the Elgin Spring, in 1846. "The substances contained in the water are

Sulphate of magnesia,	Sulphate of soda,
Sulphate of iron,	Carbonate of lime,
Carbonate of soda,	Carbonic acid gas.

Of these, the sulphate of magnesia (Epsom salts) exists in the largest quantity; probably to the amount of half a drachm in a pint. The iron and carbonates are in small quantities. There are about five cubic inches of carbonic acid in a pint of the water."

We had commenced a quantitative analysis of this water; but by the pressure of other duties have been unable to finish it. We detected the presence of chlorine in it, probably in combination with an alkaline earth. Its specific gravity is 1.005415. From 225 cubic centimeters of the water there was obtained 1.802 grains of solid matter.

CHALYBEATE SPRINGS.

98. A spring upon the farm of A. G. Stebbins, of Vernon, contained free carbonic acid, sulphureted hydrogen, peroxyd of iron, and lime.

99. CLARENDON SPRINGS.

This spring is situated in the northwest part of Clarendon, where several hotels have been built to accommodate the public.

Dr. A. A. Hayes found that one gallon, or 235 cubic inches, of the water yielded of

Carbonic acid,	46.16 cubic inches.
Nitrogen gas,	9.63 cubic inches.
Carbonate of lime,	3.02 grains.
Chlorid of calcium, Sulphate of soda, Sulphate of magnesia,	2.74 grains.

Gases are constantly evolved from the water. Of these mixed gases, one hundred cubic inches consist of

Carbonic acid gas,	.05 cubic inches.
Oxygen gas,	1.50 cubic inches.
Nitrogen gas,	98.45 cubic inches.
	100.00

These waters are chiefly remarkable on account of the great quantity of nitrogen evolved.

APPENDIX

TO THE DESCRIPTIVE AND THEORETICAL GEOLOGY.

During the progress of this Report through the press, several facts and elucidations have come to light, some of them so important that we give them in an Appendix. The most important is a paper on the fossil fruits of Brandon, prepared by Leo Lesquereux, Esq., for the American Journal of Science and Arts, but which he allows us to use also in this Report. We recently sent him an entire set of the specimens which we have figured on pages 229, 230 and 231, with a proof sheet of the same. His descriptions conform to our figures; thus rendering his paper as it were a continuation of our imperfect descriptions. We feel deeply indebted to this eminent palæophytologist for the light he has thrown on this difficult subject. He finds a confirmation of his opinion already expressed on page 240 of this Report, that the deposit containing these fruits belongs to the upper tertiary, corresponding to the famous deposit at Oeningen, in Switzerland, which we believe geologists place in the upper part of the Miocene tertiary. We have suggested that perhaps our deposit might be Pleiocene; or less definitely, newer tertiary. So M. Lesquereux concludes, although he thinks it somewhat older than the Pleiocene. But it will be seen that his researches sustain all the essential conclusions to which we had come.

ON THE FOSSIL FRUITS FOUND IN CONNECTION WITH THE LIGNITES OF BRANDON, VT.

BY LEO LESQUEREUX, ESQ.

Prof. Edward Hitchcock (in Silliman's Journal of Science, 2d Series, Vol. XV, pp. 95 to 104; and lately in a geological report of the State of Vermont, pp. 226 to 240) has already given an excellent description, accompanied with drawings of the Brandon fruits, and most satisfactory details concerning the strata with which they are connected. I owe to the celebrated Professor of Amherst College, not only the communication of the original specimens from which the drawings have been made, but also a number of corresponding specimens that he had the kindness to present to me.

It cannot be expected that the examination that I was requested to make of these fruits can afford any exact botanical determinations. Indeed an accurate analysis of the fossil fruits is mostly impossible. Their form is generally more or less obliterated, and the preserved part, the hardest of course, is often of slight value as a botanical character. By cutting a few specimens I was enabled to find some details of anatomical structure in one of the species only, and thus to mark its botanical characters somewhat more accurately than it is generally done for the fossil fruits. It is then only to point out the relation of some of the Brandon fruits with fossil species found elsewhere, or with genera of plants still living, and especially to try to come to a satisfactory understanding about the geological age of the lignite deposit, where they are found, that the few following remarks are made.

The numbers marked in this paper correspond with those of the forthcoming Report of Vermont, by Prof. E. Hitchcock. As they are not the same as those of the Journal (quoted above), it is well to mark their coincidence:

Silliman's Journal,	Fig. 1,	is equivalent to	Figs. 111 to 117	of the Report.
"	2	"	118	"
"	3	"	119	"
"	4	"	132	"
"	5	"	133	"
"	6	"	123	"
"	7	"	145	"
"	8	"	142	"
"	9	"	146	"
"	10	"	134	"
"	11	"	136	"
"	12	"	126	"
"	13	"	153	"
"	14	"	154	"
"	15	"	151	"
"	16	"	148	"
"	17	"	149	"
"	18 & 19	"	150	"
"	20	"	157	"

To facilitate further discussion about those Brandon fruits, I think that it is also convenient to give a short description of their essential character, and to name them.

1. *Carpolithes Brandoniana*, sp. nov. Capsule thick, flattened, oval or nearly round, obtuse at both ends, valvate. Valve obscurely pointed, generally opening to half the length of the capsule.

Var. *α. elongata.* Fig. 111 to 113.

Var. *β. obtusa.* Fig. 114 to 117.

Specimens figured Nos. 114 to 117 are certainly various forms of the same species, and I think that Nos. 118, 119 and 124 ought to be referred to the same genus.

2. *Carpolithes fissilis*, sp. nov. (Figs. 118, 119 and 124.) Capsule thick, a little flattened, ovate, lanceolate, obtuse or rounded below, pointed above, obtusely ten-costate, irregularly tri-valved or closed. In this species, as in the former, the size of the fruit varies from one to two inches in length, and from half an inch to one inch or more in breadth.

Nothing like the fruits of these two species has been published until now by Palæontologists. The only fossil fruit to which they may be compared is the capsule of an *Embotrium*, Heer (Flora. Tert. Helv., pl. 97, Fig. 30), and especially that of *Embotrium talignum*, a living species of the *Proteaceæ* family, a figure of which is given by the same author, on the same plate. But the fruits of this genus are borne on a strong woody stem, generally preserved in the fossil state, while our fossil fruits of Brandon do not have any scars showing the point of attach to a pedicle. They look, on the contrary, as having been inclosed either in a spathe or a fibrous capsule, like the fruits of some palms, or partly immersed in a capsule, like those of some *Cupuliferæ*. It may be that the thick fibrous and woody capsule contained originally some seeds, escaped by the dehiscence of the valves, but the total absence of seeds, even in unopened specimens, led me to suppose that the thin pellicle, which is seen within these peculiar fruits, contained a mealy cotyledon, whose form and matter have been destroyed by maceration. It is useless, however, to speculate on these fruits till something more is known about their relation to some living species. Specimens of No. 1 are extremely abundant at Brandon.

3. *Carpolithes irregularis*, sp. nov. (Figs. 120, 121, 123, 125 and 128.) Fruit capsular, about one inch in diameter, irregularly, somewhat flattened, sometimes obscurely trigonal, round-oval, marked in its length by ten irregular costæ.

These may be unopened and less flattened specimens of the same species as No. 2. They would compare well with some fossil *Carya* if they were not generally a little flattened or trigonal. Perhaps Fig. 128 belongs to another species; but it looks like a deformed specimen of this.

4. *Carpolithes Grayana*, sp. nov. (Fig. 122.) Fruit, oval-elongated, obtuse at one end, marked by a small point at the other, a little flattened, one inch long, less than half an inch broad, obscurely costate.

This species has just the form of the kernel of an almond. It is nearly related to *Carpolithes pruniformis*, Heer (Loc. Cit. Vol. III, p. 139, Tab. 141, Figs. 18 to 30.) Abundantly found in the upper tertiary of Europe, especially at Oeningen.

5. *Carya verrucosa*, sp. nov. (Fig. 129.) Fruit oval, very obscurely costate, obtuse at both ends, warty. This fruit is like *Carya Brauniana*, Heer (Loc. Cit. Vol. III, p. 93, pl. 127, Figs. 50 and 51), from Oeningen. It is a little larger than the following, but may be the same species still covered with the husk.

6. *Carya Vermontana*, sp. nov. (Fig. 130.) Nut small, about half an inch long, oval, pointed at one end, obtuse at the other, six-costate. It is extremely like *Carya Bruckmanni*, Heer (Loc. Cit. Vol. III, p. 93, pl. 127, Fig. 52), perhaps identical with it, also from Oeningen, like the former.

7. *Fagus Hitchcockii*, sp. nov. (Fig. 126 and 127.) Nut large, trigone, with the angles somewhat obtuse, striated on the sides.

This fruit has nearly the same form as a nutlet of *Fagus ferruginea*, Mich. It is only proportionally a little shorter and broader, and twice as large. Fig. 127 represents a specimen slightly open on one side of the point, with the angles more obtuse. It may be a different species, or even belong to another genus. The fruit (Fig. 126) is, indeed, very large for the nut of a beech; but Unger, in his Chloris Protogæa (p. 101, pl. 27, Fig. 1 to 4), has published a *Fagus Deucalionis* with nuts as large as those of the Brandon species. It comes from the tertiary of Bohemia.

Genus *Apeibopsis*, Heer; *Cucumites*, Bowerbank. Prof. Heer has referred this genus to the family of the *Tiliaceæ*, comparing it to *Apeiba*. It is characterized as follows: Fruit capsular, five to sixteen valvate, polyspermous; seeds small, sub-globose, biseriate in each cell. On the characters of these fruits, the author further remarks (Flor. Tert. Helv. Vol. III, p. 38): "Where the bark of the fruit is preserved, it is marked with elongated warts, and thus the fruit was externally verrucose. Within, it was probably filled with a fleshy matter, containing the seeds in small cavities. In one specimen (Fig. 20 of Bowerbank), the seeds are placed without order in the central mass. In another (Ibid. Figs. 11, 12, 21, 34), they appear to be placed in rows along the suture. Probably the fruit was divided into as many capsules as there are furrows marked on the surface; but the parietes were very thin, and lost within the fleshy matter."

This description and the remarks of Prof. Heer agree well enough with what I was enabled to see by cutting a few of our Brandon fruits evidently referable to this genus, and by a microscopical examination of their internal structure. In the American species the parietal follicle of the capsules appears thick, and each one is distinct and separated from the other in the whole extent from the folding of it at the surface to its suture with the central axis. There is thus internally six or seven lodges or capsules separated by double walls. The seeds very small indeed and very numerous, fill the capsules entirely and are apparently mixed with a fleshy or celluar matter. Those nearest to the placenta and on both sides of each capsule appear placed in rows upon the whole width of the parietes, being there perpendicular to it, more oval or a little longer than in the middle of the capsules where they are nearly globose. These seeds are inclosed in a yellowish somewhat pellucid envelope, easily separated from them and marked on its inner concave surface by regular black points or papillæ. The seeds appear somewhat papillous, or rather rugose, just like the outer surface of the fruit. The largest specimen of the fruit that I have seen is scarcely more than half an inch in diameter, nearly exactly round, or a little elongated or oval. The surface is not regularly verrucose as it is in the European species, but rather irregularly rugose, marked by seven or eight furrows a little elevated on the borders or along the line of flexure of the parietal tissue. The extremities of the central axis are marked on both sides of the fruit by a small round scar, only a little larger at the point of attach.

On the distribution of this remarkable genus, Prof. Heer says that it appears at first in the eocene of England and takes its largest development in the lower molasse of the tertiary of Switzerland, where four species have been found. It has also been found in the lower miocene of Italy and also in Bohemia, and is then apparently lost. From this it would appear that as the Brandon deposit, where specimens of this genus are abundant, belongs to the upper miocene (as will be seen presently), this genus has appeared later or persisted longer in America than in Europe. The size of our fruits, compared with that of some fruits of Europe (which have sometimes a diameter of two inches) shows that our species are diminutive, although the general form of the specimen is somewhat alike. I think nevertheless that we have two species.

8. *Apeibopsis Heerii*, sp. nov. (Figs. 131, 132, 133.) Fruit globular, deeply grooved or rugose, distinctly marked by seven furrowed costæ.

9. *Apeibopsis Gaudini*, sp. nov. (Figs. 139 and 140.) Fruit smaller, oval, depressed on one side, costæ more numerous and less marked, surface nearly smooth. It is on specimens of this last species that my examination was made. They appear abundant at Brandon; but I have seen only three specimens of the former.

10. *Aristolochia Oenigensis*, Heer. (Fig. 134.) Fruit capsular, oval, six-costate, smooth or obscurely transversally rugose.

I cannot see any difference between our American specimen and Heer's figure of this species, except perhaps that the surface of our specimen appears somewhat transversally rugose. This appearance may be due to the process of maceration. The Fig. of Prof. Hitchcock (in Silliman's Journal, Loc. Cit., 1853) is precisely the same as that of Heer (Tab. 100, Fig. 11*b*, 1856), from a specimen of Oeningen.

11. *Aristolochia curvata*, sp. nov. (Figs. 135 and 136.) Fruit capsular, small, half an inch long, oval, pointed, marked with eight strong costæ, somewhat curved on one side.

12. *Aristolochia obscura*, sp. nov. (Figs. 137, 138 and 141.) Fruit capsular, small, one-third of an inch in diameter, six or seven costate, globular or a little flattened.

This species is uncertain. The specimens are not well preserved, and I had not any for anatomical examination. I believe, nevertheless, that it is a specimen of this kind that Prof. Bailey has critically examined by a cross section. He has found it "*a six-valved pod, with seeds apparently flattened.*" This agrees with the structure of the fruit of Aristolochia.

13. *Sapindus Americanus*, sp. nov. (Figs. 142, 143, 144 and 145.) Fruit oval-reniform, either smooth or irregularly rugose, depressed or flattened on one side, about half an inch in its greatest diameter.

These fruits have the general form of some fossil species of *Pavia*. They are smaller, and moreover the cross section of one specimen shows a fleshy cotyledonous substance, inclosed in a thick, apparently hard putamen. The fruit also bears a marked round scar, showing a point of attach at its upper end. This is not marked on the figure. These characters agree well enough with those of *Sapindus* .The nearest fossil species to that of Brandon, is *Sapindus lignitum*, Ung. (Sill. Pl., p. 33, Tab. 6, Figs. 3–5) from the lignite of the Rhine (Vetteravia.) Though a little larger, our fruit resembles exactly the seed of *Cocculus Indicus*.

14. *Carpolithes bursæformis*, sp. nov. (Figs. 146 and 147.) Fruit obovate, narrowed at one end, where it bears a round, small cavity; inflated and obtuse at the other end, a little curved on one side, smooth.

I do not know of any fossil species to which this could be related. It is pear-shaped, as Prof. Hitchcock describes it, but it is a little curved on one side, the only character that separates it from a *Laurus*. As the specimens are much broken, this form may have been caused by maceration, and then the species would agree very well with *Laurus princeps*, Heer (Loc. Cit. Vol. II, p. 77, Tab. 89, Fig. 176), from the upper tertiary of Europe, especially abundant at Oeningen.

15 *Cinnamomum Novæ-Angliæ*, sp. nov. (Fig. 148.) Fruit small, one-sixth of an inch in diameter, globular, enlarged above, narrowed below to an obscurely costate point, apparently a broken pedicle, smooth.

I could not discover on the specimen the horizontal striæ marked on the figure. The fruit is like that of a *Cinnamomum*, a genus well represented in the different stages of the tertiary of Europe. Of nine species described by Prof. Heer, five are found at Oeningen. This genus, as it is established by the same author, is also represented in the tertiary of America. Among a small number of fossil leaves collected by Dr. T. Evans in the tertiary of Vancouver, there are specimens of leaves of two fine species of this genus. One other is abundant in the strata of the tertiary of Mississippi, where it has been collected by Prof. Eug. W. Hilgard.

16. *Illicium lignitum*, sp. nov. (Fig. 149.) Seed small, one-eighth of an inch long, oval, pointed, marked at the point by a small scar, and by a ring on one side, very smooth and shining.

I cannot but refer this seed to an *Illicium*. It is a little thicker and more pointed than the seed of *Illicium anisetum* of China, but about of the same size and of the same form. Two species of *Illicium* are still living in the southern part of the United States (Gray's genera, Vol. I, p. 56.) By comparison with published species of fossil plants, the seed is like the one figured by Goppert, under the general name of *Drupa* (Flora of Shossnitz, Pl. 26, Fig. 34.) The tertiary of Shossnitz is of the same stage as that of Oeningen. (Heer, Vol. III, p. 306.)

17. *Drupa rhabdosperma*, sp. nov. (?) (Fig. 150.) Seed small, about of the same size and of the same form as the former, oval-pointed or slightly beaked, finely striated, marked below the point by a deep triangular scar.

These seeds resemble those of *Pinus rhabdosperma*, Heer (Vol. I, p. 60, Tab. 21, Fig. 14), from the miocene of Switzerland. This likeness is not sufficient to prove that our seeds are of the same species or even of the same genus. Analogous forms of such small ribbed seeds are found in different genera. The putamen is pretty thick, very hard, bony, and in all the specimens that I have broken the ovule has been destroyed and the seed is empty. This ovule was covered with a brownish skin like that enveloping the albumen of the seeds of the pines. Nevertheless, the affinity of these seeds with those of a pine is rendered doubtful by the absence of every trace of a wing in all the specimens, six in number, that I have seen.

18. *Carpinus grandis* (?) Heer (Vol. II, p. 40, Tab. 72, Fig. 15.) Nutlet oval, about the eighth of an inch in length, ribbed or striated.

I have not seen any specimen of this species.* Prof. Hitchcock's Fig. 151 is like that of Prof. Heer for this species. However, it may be something different. This *Carpinus* is from the upper miocene of Switzerland.

19. *Leguminosites pisiformis* (?) (Fig. 152.) Heer (Vol. III, p. 129, pl. 133, Figs. 37 to 40.) Seed globose, perfectly smooth, shining, one-sixth of an inch broad. Round small seeds like this are found in great number in the tertiary of Europe, and have been described by some authors: The *Drupæ* (Fig. 29 and 30, Pl. 26 of Goppert's Flora of Shossnitz); the seeds of *Menianthes tertiaria* (Heer, Vol. III, p. 20, Tab. 104, Fig. 20); some species of the genus *Podogonium: Podogonium Knorrii* (Heer, Vol. III, p. 114, Pl. 135), a characteristic plant of the upper miocene of Europe, especially abundant at Oeningen; and a number of *Carpolithes*, or undetermined seeds. Though the identity of our species with *Leguminosites pisiformis*, common at Oeningen, is not certain, it is, however, remarkable that most of those seeds that have about the same form as ours belong to the upper tertiary.

*No. 151 was among the specimens sent to Mr. L.; but owing to a mistake of ours in numbering the figures, he probably overlooked it. The three specimens represented by Figs. 150 and 151 are the same, and belong to Fig. 150, or *Drupa rhabdosperma;* so that we doubt whether the *Carpinus grandis* will hold. The *Drupa* is a very beautiful and distinct species. E. H.

20. *Nyssa complanata*, sp. nov. (Fig. 153.) Fruit oval, a little flattened, bicostate, with a deep furrow in the middle.

This species particularly resembles *Nyssa Vertumni*, Unger (Sill. Pl., p. 16, Tab. 8, Fig. 19 and 20), from the lignite of the Rhine.

21. *Nyssa microcarpa*, sp. nov. (Fig. 154.) Fruit oval, scarcely compressed, regularly costate, short.—Fig. 155 may belong to the same genus, though it is longer. The point is broken, and, contrary to the figure, it is apparently obtuse at both ends, like the specimen Fig. 154. The species N 21 is related to *Nyssa ornithobroma*, Unger (L. Cit. p. 16, Tab. 8, Figs. 15 and 18), also from the lignite of Vetteravia.

22. *Nyssa levigata*, sp. nov. (Fig. 151.) Fruit cylindrical-oval, obtuse at both ends, smooth and without costæ.

The position of these fruits as they are figured, and their form, recall immediately the general appearance of the fruits of *Nyssa multiflora*. The likeness is still greater in comparing the Drupes in a dry state with the fossil fruits. The thick putamen of some *Nyssa* is well adapted for preservation in the lignites.—Though our species is nearly related to the living *Nyssa multiflora*, it differs by the size of the nutlets and the absence of striæ.

23. *Carpolithes venosus* (?) Sternb. (Vers. Vol. II, p. 208, Tab. 58, Figs. 18 to 20.) Fruit oval, about one inch long, irregularly and deeply sulcate and veined. (Figs. 157 to 160.)

This is apparently a *Carya ;* but the likeness with the species published by Sternberg, under the above name, is too great to permit a separation. Some pieces of the putamen are figured 159 and 160. It is about of the same thickness as that of *Carya olivæformis*, and marked upon its inner surface with irregularly crossed wrinkles like those of the *Carya*. This *Carpolithes venosus* was found in the lignites of Bohemia.

Before ending this examination, I have still to mention a piece of wood from the same lignites of Brandon. The wood, though somewhat hardened and blackened, is still in a good state of preservation. It is soft enough to be cut with the knife, or at least easily broken, and by a section it shows on both its sides the characters of a dicotyledonous wood. It cannot be specifically determined, of course ; but it appears like some *guglans* or perhaps a *Carya*.

Before I had had an opportunity of examining the fossil fruits of Brandon, and judging only from the drawings and descriptions made by Prof. E. Hitchcock, in Vol. XV. of Silliman's Journal of Science, I had in a letter to Prof. J. D. Dana given the opinion that the Brandon lignites were of the same age as the upper tertiary deposits of Oeningen. This opinion is fully confirmed by all that has been said above of the relation of those fruits with species of Oeningen. It is true that the identity of species is not ascertained; but this, of course, cannot be expected, and it is enough that the greatest number of the Brandon species are more generally related to the fossil species of Oeningen than to species of any other stage of the tertiary to authorize the above conclusion, and render it creditable.

It is to be regretted that the fossil flora of the tertiary of Mississippi is not better known. I have, indeed, found below Columbus, Ky., some specimens of *Carpinus* and of a *Carya*, referable to *Carya olivæformis*, in the chalk banks overlaid by ferruginous conglomerate. And in some red shales received from Mississippi I have found the fruit of a *Fagus* resembling *Fagus ferruginea*, if not indentical with it. These data are too scant to afford a point of comparison. But judging from the position of the lignites of Brandon, or rather from the nature of the strata overlying this bed, as it is marked in Prof. E. Hitchcock's paper, I can but believe that they are of the same age as the upper lignitic formation which extends on both sides of the Mississippi, and which I had opportunity to explore in Arkansas.

The general section of the tertiary of Dallas Co., Arkansas, as marked by my friend Prof. E. T. Cox, in the Geological Report of Arkansas (by D. D. Owen, Vol II, p. 410), is :

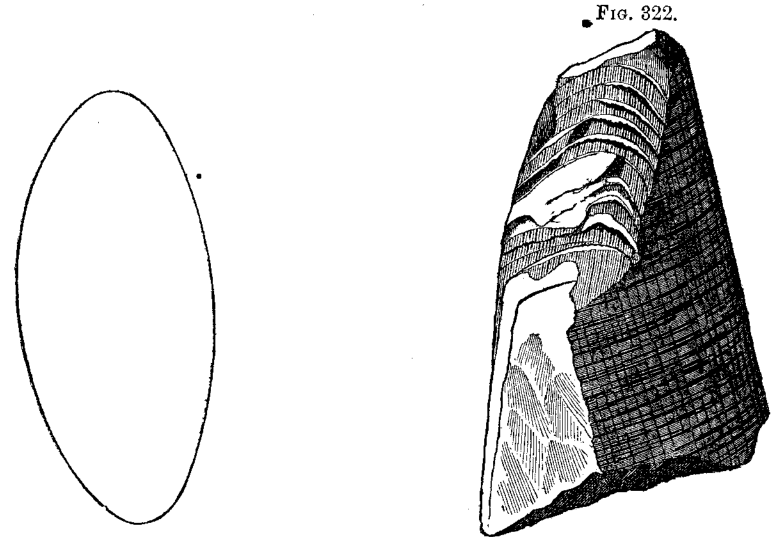
Water-worn pebbles and gravel, cemented by ferruginous conglomerate,
Place of fossil generally silicified wood,
Red, sandy clay, sometimes containing good iron ore and ferruginous sandstone ; the last much fluted,
Light-colored sand,
Upper lignite bed,
Ash-colored, sandy clay,
Plastic potter clay,
Lower lignite.

The bluff called Copperas Bluff, in St. Francis Co. (same report, p. 41), show a section much like the above. To this may be compared also many sections of the Geological Report of Mississippi, by Dr. Eug. W. Hilgard, especially that of p. 118. All show the same characters, viz., lignitic strata, overlaid at some distance by strata of iron ore or deposits of various kinds charged with iron. I know that it is still a question if all these upper lignite strata of the Mississippi shores that I consider as upper tertiary belong to the same stage. Palæontology will decide when sufficient materials are collected. I may remark only that the lignites of Lauderdale, Miss., are placed by Dr. Hilgard (p. 118 of his report), near the base of the tertiary, while the fossil plants of that locality, at least a numoer of leaves which I had opportunity to examine, show the greatest analogy with species of our time, and are apparently of as recent an epoch as the fruits of Brandon.

NEW SPECIES OF ORTHOCERAS.

One of our number, A. D. Hager, found a specimen of Orthoceras in the calciferous sand-rock formation, which Prof. Hall pronounced a new species. The other members of the Survey suggested to Prof. H. that he should attach Mr. Hager's name to it. This he has done, and kindly furnished the following description and sketch:

Fig. 322.



Othoceras Hageri.

ORTHOCERAS HAGERI. (n. s.)

"The specimen examined is a fragment as represented above, which is partly worn and partly fractured, in an obliquely longitudinal direction across the shorter diameter. The form of the section is elliptical; and, from accident or otherwise, is more flattened than the other. The septa are distant about one-fourth or one-fifth the shorter diameter of the shell. The surface, in the partially exfoliated shell, is concentrically striated with fainter longitudinal lines.

"The shell tapers somewhat rapidly, and this character, together with the extremely elliptical form, as is shown in the left hand sketch, serve to distinguish it from any of the described species in the lower Silurian strata."

This specimen was found in calciferous sandrock, in the town of West Haven, near Whitehall.

PART VIII.

REPORT RELATING TO THE GEOLOGY OF NORTHERN VERMONT.

BY REV. S. R. HALL.

Rev. E. Hitchcock,

State Geologist:

Sir,—Having performed the field work assigned to me, in completing the Geological Survey of the State, you will expect a *general report*, in addition to the profiles of the sections, the catalogue of the specimens collected, and the outlines of a geological map of *northern* Vermont, heretofore forwarded to you.—Some facts of scientific, and some things of economical importance, require a more extended notice.

The strata, in that part of the State assigned to me for examination, extend, most of them, to those parts which have been examined by yourself in person, or by other assistants.

But there are some important modifications. Most of the region that I formerly regarded *primitive*, I now regard as belonging to the lower Silurian system.

The eastern part of my field is granitic. Gneiss and several varieties of mica and altered slates are found more or less common, associated with granite in Essex county, and in the eastern part of Orleans and Caledonia counties. The evidence, that the granite has been thrown up *since* the calcareo mica slates were formed, is, to me, very conclusive. These slates, on the borders of the granite, furnish unmistakable signs of *contortion*, and in some instances of change both in the direction of the strata and dip. In more than one instance, granite is found overlying the calcareous mica slates, and in one instance, at Derby, encrinite limestone occurs below granite! In many places, jointed granite is found between the strata of slates, conformable to them, and in other instances, in dike form, crossing the strata at a large angle. One of these localities was examined by yourself at Coventry "Narrows." Others occur in the same range of hills, also in Brownington, Craftsbury and Greensboro.

A stratum of conglomerate, one hundred rods east of the western range of granite, in Newport, was also visited by yourself. Conglomerate occurs at Owl's Head and other places. Fragments of the older slates are, in many places, found imbedded in masses of granite, and retain the characteristics of the slates, without any essential change. A stratum of conglomerate, similar to that at Newport, is found at West Concord, and many large bowlders of the same at Granby, a few miles north. The locality at Concord is now covered by the waters of a mill-pond, but no doubt the conglomerate might be discovered on either side of the river, at that place.

The mountains and hills, in which granite is the principal or only rock, in a part of Orleans county, have a direction more nearly east and west than the direction of the stratified rocks. The direction of the strata is generally N. 30° to 40° E. The range of hills from Crystal Lake in Barton to Westmore Mountain, is N. 75° to 80° E. Others, in several places, are more nearly east and west. But in several towns in Essex county, the ranges have a direction N. 15° to 20° W., as in Brunswick, Bloomfield, Lewis and Brighton.—It is probable that these mountains and hills were thrown up at different periods;—those in Essex county may, generally, be of the same age as the mountains in New Hampshire, and the former, perhaps, of the same age as the Green Mountains. The range of the stratified rocks, lying west of the granite, is, with few exceptions, remarkably regular and uniform. The dip, near the north line of the State, is also remarkably uniform. From Holland to Derby it is westerly ; from thence to Newport easterly ; from thence to Berkshire westerly, and from that place to Champlain easterly. The change at Derby was, no doubt, produced by the upheaval of the granite in that town and Salem.

Between the granite and the green slates, are the calcareous mica slates of Adams. These exhibit three varieties ; a silicious limestone, capable of being converted into caustic lime, interstratified with clay and hornblende. The hornblende is most abundant near the summits of ridges, though not confined to these. The lime and clay slates are most abundant on lower lands. These, not unfrequently, change from one to the other every few inches. The limestone is seldom more than two or three feet in thickness, and often but a few inches. The clay and hornblende slates contain, usually, from ten to twenty per cent. of lime.

A striking feature of these slates, is a proneness to very rapid decomposition. By the combination of silex, lime, argillite and hornblende, a soil of great excellence is formed. Most of these slates contain sulphuret of iron, which, by its rapid decomposition, combines with the lime, and furnishes a very important aliment to agricultural products.

The towns in the central part of Orleans county, and in Caledonia and the eastern portion of Washington counties, lie mostly in the calcareous mica slate region, and are unsurpassed, perhaps, for excellence of soil, by any other portion of New England. These lands will be rich, when western prairies have become poor !

The green slates, lying west of the calcareous mica slate region, and which have heretofore been denominated talcose, and chlorite, extend from Memphremagog lake, to the Champlain valley. The western part of Orleans county, all of Lamoille, and the eastern and central part of Franklin, lie in this region.—Ranges of clay slate—usually narrow—and of serpentine and steatite extend from Canada line to central Vermont, if not through the State. A range of clay slate, found in the upper Missisco valley, extends, no doubt, to Northfield. The ranges of serpentine in the same valley, may, doubtless, be traced to the south line of the State, but in no other place so wide as at Troy and Jay, Westfield and Lowell.

The talcose slates vary very much in hardness. Near the summits of the Green Mountains, veins of quartz are so numerous as to destroy the slaty structure. In a few places the rock is almost entirely quartz, and sometimes granular. The rock on the western side of the green slates is chloritic, and less slaty, especially in Franklin county.

Ranges of serpentine and steatite are found at Richford, west of the highest part of the Green Mountains, which may be easily traced through Montgomery and Belvidere, to Sterling Mountain, and probably to Moretown and Waitsfield. These ranges follow very nearly the direction of the strata. Asbestus is usually found with the serpentine, and in some instances is very beautiful. Diallage, actinolite and talc, also abound. Of the Champlain group, embracing Stockbridge and other limestones, black and dove marbles, variegated and calciferous sandstones, clay and Utica slates, conglomerate, breccia, etc., I need not speak, as your own examination of them, in connection with that of your son, will enable you to communicate every thing which is important. Indeed, the great value of many of these rocks demands a more full report than would be consistent with the brevity designed in mine.

Aside from the building stones in the Champlain group, none are found of great value within the limits of my field, except granite and gneiss. Of both of these, many excellent quarries are found in Essex, Orleans and Caledonia counties. Much of the granite in the valley of the Connecticut answers a good purpose for millstones, and has been so employed from the earliest settlements. The best quarry examined is in Maidstone, near the north line of the town, and within a few rods of the river road. Very valuable quarries of gneiss are found on the east side of Morgan lake, also at Victory. Stones from these quarries, suitable for doorsteps, underpinning, window caps, etc., are procured with trifling labor, and require but little dressing.

A very large part of the granite used as a building stone, in the north-east part of the State, has been procured from bowlders, scattered in almost every town. A single stone, in East Craftsbury, would have sufficed for the walls of Solomon's temple—all of which has been removed. An elegant stone house in the south part of Greensboro (widow Tolman's) was constructed from a bowlder on the farm, which also furnished stone for underpinning to many in the neighborhood. Others of similar size and quality remain for future use. These bowlders split almost uniformly in the direction desired, and with but little labor. They were doubtless removed from a hill in the south-west part of Irasburgh, where similar stone might be quarried sufficient to build a city as large as Boston. A quarry in the north-western part of Greensboro would not be exhausted in many thousand years, even if used as freely as the syenite of Quincy, Mass.

Beds of beautiful jointed granite abound in many towns. It may be employed with no labor except quarrying.

An immense quarry of granite, on the east side of Crystal lake in Barton, would supply stone sufficient for all the railroad bridges and culverts in New England.

A very singular variety of granite is found in Orleans and Washington counties, which claims notice.—On the east side of Memphremagog lake, in Stanstead, C. E., is a bed or range of granite, fine-grained and compact, in which, for a short distance, nodules of black mica and quartz are sparsely disseminated, one or two in a square foot of surface. This range of granite may be traced from that place through Derby, Brownington, Irasburgh, Craftsbury and Calais, to the south-west part of Northfield. These singular nodules seem to be imbedded in the granitic mass, "like plums in a pudding." They extend only a short distance from the place where first found in Stanstead. From that place to Craftsbury the granite exhibits no unusual appearance. At the south village in the latter town is an immense bed of nodular granite, some of which seems to be composed almost entirely of nodules, slightly cemented by grains of mica and quartz. Other parts of the rock are very solid, and not inclined to decomposition, more than other granite. A part of the granite is very dark, and a part light colored. The varieties of form are so many that quite a cabinet of specimens may be obtained, and no two would be alike. Veins of jointed and talcose granite have been protruded since the nodular granite was thrown up. These *veins*, if they are such, have no nodules, and are less crystalline than the older rock.

I am sorry to say, that the specimens obtained by Mr. Williams, for the State Cabinet, fail to exhibit *all* the varieties, or the best that might be secured. I was providentially prevented from being with him when he visited that interesting locality. From Craftsbury to Northfield, where the granite terminates, none of these nodules appear, except in the rolled stone, which originated at the former place. At Northfield, are found a few nodules, similar to those at Stanstead. I regard the nodular granite as the greatest geological curiosity of New England. It should be visited by all able geologists. The talcose granite of Craftsbury, on the farm of Wm. Scott, would, probably, make a valuable lining for furnaces.

The immense amount of serpentine and steatite, in the upper Missisco valley, has, as yet, been employed but little for any purpose. Specimens as beautiful as any of the Verd-antiques of Europe, may readily be obtained at Jay, Troy or Lowell. Much of the steatite has either sulphuret of iron or quartz in it, injuring it for a building stone, but no doubt beds exist free from either. It may be found in hundreds of localities.

On an island in Memphremagog Lake, a locality of novaculite has long been known, equal, if not superior, to the "honestone" of Turkey. The rise of the water in the lake, in consequence of a dam at the outlet, has lessened the value of this locality. A stratum of similar stone extends from the borders of the lake to Irasburgh. Millions of tons might easily be quarried, a few rods west of the north end of Irasburgh pond. The specimens found near the surface are hard, but, no doubt, stone may be obtained as valuable as that from Memphremagog Lake. A quarry in Newport has been opened, and was wrought for several years with profit to the owners. The stone gave great satisfaction in the market, and will doubtless be quarried by the present owners, when the facilities for transportation, now in progress, shall be completed. The quantity is adequate to the wants of the world.

Ores of iron and manganese are found in several places, in the field I have examined. Mountain manganese occurs at Coventry, Albany and Berkshire. No efforts, however, have been made to explore either of these mines. The Berkshire manganese, in the north-east part of that town, seems to be extensive, and of excellent quality, and will, no doubt, be found valuable at a future period. The bed is 15 feet wide at the surface, and is seen in the direction of the strata, for many rods.

At Troy, an immense vein of magnetic iron ore was discovered near thirty years ago in serpentine rock !! and a blast furnace was constructed, and improved for many years. The ore contains titanium, and a trace of manganese, and is hard to smelt, unless mixed with hematite or bog ore. The hollow ware, or wrought iron from it, was usually excellent. It is well adapted to make wire, screws, etc., having great strength and tenacity. The former owners of the ore and furnace labored under many disadvantages, from want of adequate knowledge and skill, also by great distance from market. The present owner, being concerned in other and more lucrative business, has been indisposed to continue the manufacture of iron, and the buildings, etc. are in a state of rapid decay. No better ore is found in the State; and when railroads become available for transportation, no doubt its value will be appreciated, and it will be wrought with advantage, both to the owners and community.

A vein of red hematite extends from the eastern part of Berkshire, or rather from Broome, C. E. to Milton. It appears at several places in Berkshire, at Sheldon, Fairfield and St. Albans. It has been wrought at the three towns last mentioned, but competition with manufacturers in New York, where ore could be obtained more easily, so diminished profits that the business has been abandoned.

Several veins or beds of chromate of iron have been found in the serpentine of Jay, Troy and Westfield. The ore at Jay was brought to notice by Prof. Adams and myself in 1846, and is quite fully described in the report for that year.

Prof. Adams says, " It occurs in veins somewhat irregular, of which the largest is from one to two feet wide, and we were assured by Mr. Farwell that it also occurred at a spot some thirty rods north, which we perceived to be in the direction of the vein, but the circumstances of our visit prevented further exploration. The great importance of this discovery was readily understood, and several individuals have followed up this with additional discoveries, of which we are unable at present to give a description. The principal vein which we examined in person, now belongs, as we are informed, to W. W. Huse, Esq.,whose skill and enterprise, so advantageously exhibited in the management of the Troy furnace, may be expected to render the ore available.

A partial analysis has been made by my friend and college associate, Prof. Twining, who has made 180 grains of chrome yellow, from 100 of the ore, without exhausting the chromic oxyd of the latter; the appearance and specific gravity indicate its richness."

It is now owned by persons residing in New York, who have, as yet, neglected to make any thorough examination of the extent of the beds. The ore has been sent to London for examination, and there pronounced of superior excellence, but the quantity has yet to be ascertained. For an account of the value of chrome, see Ure's Dictionary of Arts, Manufactures and Mines, Appleton's edition, 1845, pp. 300 to 303.

Small quantities of specular oxyd of iron have been discovered at Richford, Eden and Hydepark, furnishing beautiful cabinet specimens.

Several years ago a vein of galena was discovered in the north-east part of Morristown. The ore is rich, but the quantity must be ascertained by those more enterprizing than the present owners, before its importance can be known. An expenditure of a few hundred dollars might result in opening a valuable mine, and prove economical to proprietors.

Sulphuret of copper exists in Newport, on a hill two and a half miles south-west of the lake.— But no examination has been made to ascertain either the quantity or richness of the ore. It is, probably, similar to that at Corinth, and may be a part of the same vein.* Small specimens of gold have been found at Jay, and other places, but not of sufficient value to make the fact of much interest. Time may be more profitably devoted to cultivating the rich soil of Vermont, than in searching for gold in her rocks and mountains. While the iron ores and manganese of northern Vermont are, no doubt, of considerable importance, and the marbles and limestone of the Champlain valley are immensely valuable, I must regard the extensive beds of sphagnous muck and the deposits of shell marl of still greater value to the State.

Muck is found most abundant in the Champlain valley and the calcareous mica slate region, and is also more valuable in these parts of the State, than where the granite and talcose or green slates abound.

* Examined, since the above was written, and found worthless.

Deposits of shell marl are limited to those places where limestone is found in place.

Muck or peat is not only very useful in many other respects, but its great importance is that it furnishes abundant supplies of the best *manure.* Agriculture being the great interest of the State, every thing which " favors its prosecution, and increases its products and profits," ought to claim *special* consideration.

Should any facts presented in this Report awaken greater interest on the part of those who cultivate the soil, to the resources for improving its productiveness within their reach, my *highest aim will be attained.* I ask the special attention of agriculturists to the following statements:

" Peat or muck is mostly formed by the growth of sphagnous mosses, the roots and submerged stems of which die and decompose, while the plants grow from their upper parts, and furnish a continual supply of carbonaceous matter, consolidating, by their functions, a portion of the carbon contained in the carbonic acid gas of the atmosphere." (*Dr. Jackson.*)

Dr. Emmons [Third Annual Report of the Second Geological District of New York] remarks, "The value of a marsh of peat may be estimated by determining the worth of a cubic yard or load, or any given quantity, and then calculating the amount contained in a given area."

" The quantity in a square rod of surface, worked to the depth of fifteen feet, would furnish 142 loads, which may be considered worth 50 cents a load." A small area therefore, on any farm, "*might be employed to increase its value one half*, as it would furnish an abundance of manure for an indefinite period." If we take this statement as true, and its truth is capable of easy demonstration, then the towns lying within the calcareous mica slate region, and also in the Champlain valley, where limestone abounds, *have exhaustless resources for agricultural wealth.*

In 1847 and '48, I surveyed, with considerable accuracy, the muck or peat beds of the town in which I resided [omitting those of limited area], and found there was an amount equal to 640 cords [1280 cart loads] *for every acre of land in town!* That town is not any better supplied with this substance than many others.

At 50 cents per load, the value of muck in it equals nearly 50,000 dollars. But if we rely on the analysis of Dr. Dana [Muck Manual, pages 163 and 4], who says, "The salts or gein of a cord of peat are equal to the manure of one cow for three months," it is of greater value.

" Departing from cow dung and wandering through all the varieties of animal and vegetable manures, we land in a peat bog. The substance under our feet is analyzed, and found to be *cow dung* without its musky breath of cow odor, or the power of generating ammonia. That process is over. A part of the ammonia remains still evident to the senses by adding caustic potash." Muck from many localities requires the addition of caustic lime or ashes—or to receive for a time the liquid manure of the stable. Thus prepared, its value is greater than cow dung, for crops either of corn, wheat, potatoes, or grass.

Any farmer, who either has, or can construct a cellar under his stables, in which he can place muck during autumn, to the depth of four feet, will need no other mode of preparation. If placed in a shed where cattle lie during winter, or even in the center of a barn-yard made considerably dishing, or in the yard appropriated for hogs, no other preparation will be required. The quantity of manure may thus be doubled, or even quadrupled, at small expense, where muck can be procured near the premises. Two bushels of ashes or one bushel of unslacked lime, will be sufficient for a cart load of good muck. It may be employed as soon as mixed with lime or ashes.

Where muck is shallow and has considerable amount of grass roots in it, it should be thrown up into heaps, and lie a year before using. When dry before placing in a barn cellar, it will more readily absorb and retain the liquid manure of the stable. Beds of muck several feet thick, are more valuable than those which are shallow. Such muck may be used advantageously, as soon as it can be mixed with ashes or lime, either as a top dressing for grass, or on ploughed lands. A large heap should be annually placed near every house, to receive the waste water, suds, &c. [See letter of Mr. Steele.] The wash of the house thus applied and saved, would result in an annual benefit to the State, of several hundred thousand dollars.

Nearly all the peat or muck of Vermont would answer a good purpose for fuel, but at present it is not needed. It would furnish an abundance of carbureted hydrogen, if employed for producing *gas light*, much less expensive than coal, oil or resin. "The gas is harmless, inoffensive, and has, in respect to healthfulness, great advantages over some other kinds." "After it has been employed for gas, it may be used for fuel, and is equal to any charcoal." (*Dr. Emmons.*)

"Perhaps it would be saying too much to assert that peat is more valuable than coal, but, when we consider that for creating heat, it is not inferior to bituminous coal; that it contains gaseous matter, equal in illuminating power to oil or coal gas; that its production is equally cheap, and in addition to this, it is a valuable manure, if properly prepared, the intrinsic worth of peat (muck) cannot fall far short of the poorer kinds of coal." "Since the above was written, I have been informed, by an intelligent gentleman, that peat as a fuel for steam engines has been proved, by actual experiment, of great value."—(*Dr. Emmons.*)

The area covered by muck, in many towns, is such that there is no danger of exhaustion for many centuries. In Morgan, Derby, Charleston, Salem, Newport, Brownington, Barton, Glover, Coventry, Albany, Craftsbury, Greensboro, Hardwick, Danville, Lyndon, Sutton and Peacham, the area will exceed more than a square mile in each. In the latter town, there is *one* bed of about a square mile. The towns on the islands in Lake Champlain, and bordering on it, are equally well supplied. The depth varies from one to fifty feet.

The average depth of beds of sphagnous muck, in the calcareous mica slate region, may be estimated at ten feet. Many, indeed, are less, and those most convenient for transportation, perhaps, are not more than four or five feet in depth. Many of these may be easily drained, and the muck removed with nearly as great facility as the manure from the barn-yard. The beds of greatest extent are often 20 or 30 feet deep.

It is an interesting fact, that in the counties of Orleans, Caledonia, and a part of Washington, beds of muck are so numerous, and so well distributed, that almost every agriculturist can obtain a supply, without great expense for transportation. In some towns almost every farm has its supply.

When found lying above shell marl, it is always of excellent quality. In many instances, where the wash from roads and buildings finds its way to muck beds, the muck may be employed advantageously, without any preparation, for a top dressing for grass lands. In addition to the foregoing suggestions, I ask attention to the following letter from an intelligent agriculturist, which will explain itself:

"Rev. S. R. Hall:

Dear Sir,—In compliance with your request I seat myself this evening to give you a hasty statement of my experience in the relative value of swamp muck, as a fertilizer, compared with other kinds of manure.

In the fall of 1855, I had a little less than three acres of land which I intended for corn the ensuing year. The land was a high plain, composed of gravel and loam. It had been in grass, and mowed for several years. It was plowed in the spring of 1854, and sowed to oats without manure. In the spring of 1856, we spread on ten loads long manure, taken from the yard and stables, and plowed it in. We then harrowed the ground *thoroughly*, and marked it out in squares three feet each way, and manured in the hill as follows:

In the fall previous, I had prepared a heap of compost, one-third swamp muck, and the balance decomposed manure, taken from the cow-yard, and covered the whole with earth, to be ready for use in the spring. I also prepared another heap of swamp muck in the back yard near the house, and boxed it up with boards, leaving the top in a concave shape. To this we applied all the soap suds, chamber water, &c., from the house during the winter. In the spring I had about five loads of manure in my hog yard. Though rather coarse, I considered it by far the best manure I had, which I intended for the hill, together with the other two heaps above mentioned. Early in the spring I added about one-twentieth of leached ashes to the heap of compost, and mixed the whole well together, and on the 14th of May the dunging in the hill, and planting, commenced: First with the hog manure; second, with the heap of saturated muck; third, from the heap of compost. The whole field was finished on the 19th of May. The soil and condition of land was nearly the same. The seed planted was the long eight-rowed yellow corn. I cultivated the field two ways with a Boston Cultivator, and hoed four times. At the time of harvesting, the field was

quite free from weeds. After the first hoeing I applied one hundred pounds plaster to the acre. Result as follows:

The whole field produced 417 bushels of well dried ears of corn, and a little more than twenty-five bushels of what we called "pig corn." The best corn and the greatest yield, was taken from that portion where the muck was applied; second, from that portion over the hog manure; third that portion over the compost.

I am unable to state the exact number of bushels of corn grown upon this piece of less than three acres of land, from the fact that all my buildings were burned on the twenty-fifth of Nov. following, and nearly all the corn, but I have no doubt but the whole would have measured out fully 230 bushels in prime order for market.

I should add that all the muck was dug from the pit in June, and when put in the heap was quite dry. What effect was produced upon this muck, by the application of this waste water from the house, I leave for chemists to determine. Such are the facts in the case, and if it be true that twenty loads of muck can be rendered more valuable than the same amount of *any other* manure, by the process above mentioned, and as we know that the muck required is to be found in abundance upon almost every lot of land in Orleans county, we really see no good reason why our young men should leave the graves of their fathers, and wander in the far West in search of a better country than our own. I have the honor to be, sir,

Your obedient servant,

SOLO. STEELE.

Derby, Sept. 23, 1859.

Shell marl is found throughout the calcareous mica slate region, and also on some of the islands, and in most of the towns bordering on Champlain Lake. The most important localities of marl, recently examined, are in Holland, Derby, Salem, Albany, Craftsbury, Glover, Greensboro, Hardwick, Walden, Sutton, Lyndon, St. Johnsbury, Barnet, Peacham and Calais. At Williamstown, Royalton, Woodstock and Alburgh, large and very valuable marl beds were examined, during the year 1846. Smaller beds were noticed in many other towns.

Marl is composed principally of the shells of *cyclas* and *planorbis*, many of which are not yet entirely decomposed. If there is no admixture with clay, or other matters, it is nearly pure carbonate of lime, and may be converted into caustic lime by burning. It is not inferior to the best stone lime for mortar, and is invaluable as a manure, especially when combined with muck.

As a large tract of land in the State, on both sides of the marl region, east of the Green Mountains, is destitute of good limestone, the value of these deposits is greatly enhanced. Every crop taken from the land, and every animal fattened for the market, diminishes the quantity of lime in the soil. This must be supplied, or lands must deteriorate in productiveness. Much land, in the granitic and green slate region, has already diminished in fertility. I beg leave, therefore, to repeat the concluding part of a Report made thirteen years ago. Its importance has not diminished by the lapse of time.

If any one will take the pains to compare the Reports of the Cambridge and Brighton Cattle Markets for a year, he will find that a greater number of cattle and sheep are annually sent to these markets from the small territory of Vermont, than from all the rest of New England. Of course, the drain upon our soil, in these respects, is as much greater. In order to maintain our previous and present high distinction, we must prevent, by other means, the deterioration of our hitherto exuberant soil. Every farmer's son in the State should, therefore, be urged to make himself familiar with the subjoined facts, as well as those which precede, with regard to muck and shell marl, that when he may be called to the cultivation of the soil he may know how to augment its fertility, and increase the profits of agriculture.

By the analyses of different kinds of grain, &c., the importance of certain elements in the soil is made apparent. The following analyses of the more important grains, also of the various kinds of manure, that may be most readily applied as fertilizers, will be conducive to the objects contemplated by the department of the geological survey assigned to me. These analyses of grains and straw are taken from Sprengel:

The figures in the several columns indicate the number of pounds contained in one thousand pounds of the articles named in the first column :

	Potassa.	Soda.	Lime.	Magnesia.	Alumina.	Oxyd of Iron.	Oxyd of Manganese	Silica.	Sulphuric Acid.	Phosphoric Acid.	Chlorine.
Wheat,	2.25	2.40	.96	.90	.26			4.00	.50	.40	.10
Barley,	2.78	2.90	1.06	1.80	.25			11.82	.59	2.10	.10
Rye,	.05	32.00	1.22	.44	.24	.42	.34	1.64	.23	.46	.09
Oats,	1.50	1.32	.86	.67	.14	.40		19.76	.35	.70	.10
Beans,	4.15	8.16	1.65	1.58	.34			1.26	.89	2.92	.41
Peas,	8.10	7.39	.58	1.36	.20	.10		4.10	.53	1.90	.38
Potatoes,	40.28	23.34	3.31	3.24	.50	.32		.84	5.40	4.01	1.60
Wheat straw,	.20	.29	2.40	.32	.90			28.70	.37	1.70	.30
Barley straw,	1.80	.48	5.54	.76	1.46	.14	.20	38.56	1.18	1.60	.70
Oat straw,	8.70	.02	.52	.23	.06	.02	.02	45.88	.79	.12	.05
Rye straw,	.32	.11	1.78	.12		25.00		22.97	1.70	.51	.17
Bean stalks,	16.56	.50	6.24	2.09	.10	.07	.05	2.20	.34	2.26	.80
Pea stalks,	2.35		27.30	3.42	.60	.20	.07	9.36	3.37	2.40	.04
Potato stalks,	81.90	.90	129.70	17.00	.40	.20		49.40	4.20	19.07	5.00
Rye hay,	8.81	3.94	7.34	.90	.31			27.72	3.53	.25	.06
Red clover hay,	19.95	5.29	27.80	3.33	.14			3.61	4.47	6.57	3.62
White clover hay,	31.05	5.79	23.48	3.05	1.90	.63		14.73	3.53	5.05	2.11
Lucerne,	19.40	6.15	48.31	3.48	.30	.30		3.30	4.04	13.07	3.18

By computing the weight of the grains, straw or hay removed from an acre of land each year, it will be easy to ascertain the quantity of potassa, lime, &c., taken from the soil of that acre by any given crop. If an acre of wheat yield 25 bushels, the weight of grain will be 1500 lbs.; and the straw about twice as much, say 3000 lbs. Of course one and one half times as much potassa, &c., will be taken from the land as the amount in the table against wheat, and three times as much as the amount against the straw of wheat. Thus if an acre of red clover yields two tons (4000 lbs.), the soil of that acre loses 79.80 lbs. of potassa, 21.16 lbs. of soda, 111.20 lbs. of lime, 26.28 lbs. of phosphoric acid, and 17.88 lbs. of sulphuric acid, &c., each year.

The analyses of various kinds of manure, which I shall subjoin, will show the value of them as fertilizers of the soil.

Notwithstanding the diversity of soils in this State, and the fact that some are much better adapted to the purposes of agriculture than others, it is yet doubtless true, that the amount of the produce of the soil depends as much, not to say more, on the manner of tillage and the character of manures. As all soils, even the richest, must diminish in strength by the removal of crops, as just explained, it becomes a question of the highest importance, what are the most economical fertilizers that can be applied? To answer this question accurately, is not possible without some knowledge of the character of the soil in a particular section or district. In some places the application of wood ashes may be of very essential service, while in others of but little. In some districts gypsum may for a time be found highly valuable, but in others of no value at all. The application of shell-marl may be greatly beneficial to soils, where there is a deficiency of carbonate of lime, but of no service where this exists sufficiently already. But while these facts are admitted, it is doubtless equally certain that the sources of manure available to every farmer, are, through the benevolence of Providence, adequate to the wants of every variety of soil in Vermont. It may be true economy to expend twenty dollars to purchase and transport a ton of plaster of Paris, to apply to a given farm, but it is doubtless true that fertilizing substances of greater value than this, to that particular farm, are often allowed to waste — to save or preserve which, would cost much less.

It is, doubtless, capable of practical demonstration, that every acre of arable land in the State may be made highly productive by the application of the manures available to every farmer on his own premises. The native soil of the State will not, probably, suffer by comparison with any other,— the natural resources for manure are not exceeded, if equaled, by any other. These resources are, to a great extent, so distributed as to be conveniently available in a large proportion of that part which has been examined the present season; but the writer has been forced to believe that these advantages, great as they are, are less than

those which would be secured by saving and applying the fertilizing substances now almost entirely lost.— If the urine of the cattle in the State, and the valuable liquid manures of the houses were preserved, and applied to the soil in a proper manner, there can be no reasonable doubt that the land now under the scythe and plough, would yield double the present amount of produce.* If this be true, or if only half that increase might be realized, the benefits of railroads to the State, great as they doubtless may be, will be far less than those which would follow the saving and applying such manures. Agriculture is the great interest of the State. The capital invested in it is many times greater than the amount invested in anything else. Improvement here, is therefore of more consequence than elsewhere. When improvement can be effected without a heavy expenditure of capital,— when to provide for saving twenty dollars will cost but five, and this not money but labor,— surely information how to do it can hardly be valued too highly by any people entertaining just views of political economy.

It may be important, as a means of making the following analyses better understood by those not familiar with chemical terms, to remark that urea, which is found so abundant in urine, consists of carbon 20 per cent., hydrogen 6.6 per cent., nitrogen 46.7 per cent., oxygen 26.7 per cent.

"It is, therefore, far richer as a fertilizer than animal flesh, or blood, or any of those other richly fertilizing substances, of which the main efficacy is supposed to depend upon the large proportion of nitrogen they contain." Urea possesses another remarkable property. During the fermentation of urine, it changes entirely into the "carbonate of ammonia. It hardly need be said that ammonia is one of the most fertilizing agents applied to soils." The efficacy of urine as a manure depends upon the quantity of solid matter which it holds in solution, and the nature of this solid matter, and the change which the organic part is known to undergo. The following table, by Prof. Johnston, exhibits the average proportions of water, and of the organic and inorganic matters contained in the urine of man and other animals in their healthy state, and the average quantity voided by each in twenty-four hours.

Urine of	*Water in 1000 parts.*	*Solid organic matter in do.*	*Solid inorganic matter in do.*	*Total.*	*Amt. voided in 24 hours.*
Man,	969	23.4	7.6	31.0	3 lbs.
Horse,	940	27.0	33.0	60.0	3 lbs.
Cow,	930	50.0	20.0	70.0	40 lbs.
Swine,	926	56.0	18.0	74.0	(?)
Sheep,	960	28.0	12.0	40.0	(?)

The above table will show that the urine of the cow, by the quantity of solid matter it contains, is much more valuable than that of any other domestic animal, on account of the greater quantity voided, and its richness in fertilizing salts.

Berzilius found human urine to contain in 1000 parts:

Water, ...	933.0	Phosphate of soda, ...	2.9
Urea, ...	30.0	Phosphate of ammonia, . . .	1.6
Uric acid, ...	1.0	Common salt, ...	4.5
Lactic acid, lactate of ammonia, . .	17.1	Sal ammonia, ...	1.5
Sulphate of potassa, ...	3.1	Phosphate of lime, magnesia, &c., .	1.1
Sulphate of soda, ...	3.2		

* *Waste of Urine.* "The great quantity of solid matter contained in the recent urine voided in a year by a man, a horse, and a cow, and the weight of ammonia they are respectively capable of yielding, may be represented as follows:

	Quantity of Urine.	*Solid Matter.*	*Containing of Urea.*	*Yielding of Ammonia.*
Man, . .	1,000 lbs.	67 lbs.	30 lbs.	17 lbs.
Horse, . .	1,000 "	60 "	(?)	(?)
Cow, . .	13,000 "	900 "	400 "	230 "

How much of all this enriching matter is permitted to run to waste? The solid substances contained in the urine, if added to the land, would be more fertilizing than guano, which now sells at $44,40 per ton. If we estimate the urine of each individual at only 600 pounds, then there are carried into the common sewers of a city of 10,000 inhabitants, a yearly weight of 6,000,000 pounds, 3000 tons of manure, which, at the present price of guano, is worth $133,200, which would, no doubt, prove more fertilizing than its own weight of guano, and might be expected to raise an increased produce of not less than double the number of bushels of grain." *Prof. Johnston's Lectures.*

Sprengel, who has very carefully analyzed the urine of cattle, finds it to contain in 1000 parts— the first column showing an analysis of fresh urine ; and the second, of urine mixed with an equal quantity of water and allowed to ferment four weeks in the open air:

Water,	926.2	934.8	Sulphuric acid,	4.0	3.3
Urea,	40.0	6.0	Phosphoric acid,	0.7	1.5
Mucus,	2.0	0.3	Chlorine,	2.7	2.7
Hippuric and lactic acid,	6.1	6.2	Lime,	0.6	trace.
Carbonic acid,	2.6	15.3	Magnesia,	4.0	4.0
Ammonia,	2.1	16.2	Alumina, oxyd of iron and oxyd		
Potassa,	6.6	6.6	of manganese,	0.1	——
Soda,	5.5	5.6	Silica,	0.4	0.4

It will be seen that when fermented the quantity of urea is greatly diminished, while carbonic acid and ammonia are greatly increased. The former is converted into the latter. When urine* is allowed to unite with brown muck, or with dry earth placed in a cellar under the stable, fermentation takes place, and the ammonia is mostly absorbed and preserved by the muck or earth, and may be easily applied to the soil.— Straw, &c., placed in such a cellar, will absorb and take up a less quantity of the ammonia of the urine. It becomes, however, a valuable manure, when allowed to remain sufficiently long to become thoroughly rotted or decomposed. Mr. Penot found in 100 parts of fresh cow dung:

Water,	69.58	Carbonate of lime,	0.24
Bitter matter,	0.74	Sulphate of lime,	0.25
Sweet substance,	0.93	Phosphate of lime,.	0.46
Chrophylee,	0.28	Carbonate of iron,	0.09
Albumen,	0.63	Woody fiber,	26.39
Muriate of soda,	0.08	Silica,	0.14
Sulphate of potash,	0.05	Loss,	0.14
			100.00

"In 100 lbs. of cow dung, scarcely one-sixth is of any value in agriculture." The ammonia contained in both the liquid and solid manures of the barn, being exceedingly volatile, mostly evaporates, and so passes into the air when exposed to the action of the wind, &c. All manures should therefore, as far as possible, be protected in barn cellars or by sheds, by which great loss will be prevented.

Several facts of scientific interest, are perhaps worthy of notice, in this Report, that have not been embraced in preceding remarks. It is quite common to find the head waters of streams flowing in different directions, originating in the same swamp or bog. Great Averill Pond discharges its waters by Averill stream, into the river St. Lawrence, and through the gulf of St. Lawrence into the Atlantic ocean. Not more than half a mile east of Great Averill Pond, is Little Leach Pond, of almost the same level, a swamp being between them. The waters from this pond flow into Great Leach Pond, and from thence into the Connecticut, through which they pass into Long Island Sound.

A few miles south, the waters of Spectacle Pond pass into Island Pond, and through Clyde river, and Memphremagog Lake into the Gulf of St. Lawrence. The head waters of the Nulhegan flow from the swamp bordering on Spectacle Pond into the Connecticut River and Long Island Sound.

*Dr. S. L. Dana, of Lowell, to whose experiments on manures agriculture is greatly indebted, remarks: "Let this [urine of cattle] now be compared with the value of cow dung. One hundred pounds of cow dung contains two pounds of carbonate of ammonia. One hundred pounds of urine contains four pounds of ammonia in its urea, besides that in its other ammoniacal salts. The quantity of liquid manure produced by one cow annually, is sufficient to fertilize one acre and a fourth of ground, producing effects as durable as the solid evacuations. A cord of loam saturated with urine, is equal to a cord of the best rotted dung. If the liquid and solid evacuations, including the litter, are kept separate, and soaking up the liquid by loam, it is found they will manure land in proportion by bulk of seven liquid to six solid, while their actual value is two to one. One hundred pounds of cow's urine affords about eight pounds of the most powerful salts that have ever been used by farmers." It is more important "to save the last than the first." "Let both be saved." Grass land saturated with urine only, yields nearly double to that not so manured. Muck saturated with urine, as a top dressing for grass lands, is invaluable.

Waters flow from the same swamp—a part into Black River and Memphremagog Lake, and part into Missisco River and Champlain Lake. Hundreds of similar instances might be specified, in Orleans and Essex counties, where the height of land dividing the waters that flow east and south into Long Island Sound, from those that flow west and north into the St. Lawrence, could scarcely be detected by the eye, and is ascertained only by the direction of the streams.

Many similar instances occur, where waters from nearly the same level flow into the Lamoille River and Black or Barton River.

Another fact may also be mentioned, to which I alluded during your visit to Willoughby Lake. On the borders of several lakes and ponds, within the limits of my field, is a ridge of sand, and water-worn stones, rising in some instances to the height of eight or ten feet, and hardly a rod in width. These occasionally are composed of stones weighing from 500 to 1000 pounds, but more generally the stones are much smaller. The present road on the side of Franklin Pond is constructed, for considerable distance, on such a wall or ridge, thus forming a natural turnpike. The swamp on one side is but little higher than the waters of the pond on the other.

In most instances, these pond walls are not sufficiently wide to admit of forming a road over them. I have marked the most remarkable of these on the map already forwarded. Island Pond, Averill Lake, Willoughby Lake and Franklin Pond, furnish examples worthy of special notice. The inquiry, how were these formed ? I shall leave for others to discuss.

An event occurred in the county of Orleans, in the year 1810, that deserves some mention in this Report. Within the towns of Greensboro and Glover, a considerable body of water, known as Long Pond, existed at an elevation of fourteen or fifteen hundred feet above the level of the sea. It furnished the head waters of Lamoille River, and flowed south. It was near two miles in length, and from one-half to three-fourths of a mile wide, and, excepting near the outlet, was very deep. Its greatest extent was north and south.— At the distance of one hundred rods from this pond, northerly, was another pond of half the area of Long Pond, and on a level 150 feet lower, which discharged its waters northerly into Memphremagog Lake.

For about 500 yards from the southern extremity, Long Pond was very narrow ; and the water not more than ten or fifteen feet deep. It then made a sudden deep descent in its bed, to the depth of one hundred feet or more. Here, also, the pond opened rapidly to the breadth of one-half a mile, and then more gradually to three-fourths of a mile. The depth also increased probably to 150 feet, in the broadest part, and did not diminish in depth, till within a short distance of the northern extremity, where its width was about half a mile. On the east and west, the shores of the pond were bold, and rose into hills of considerable height. Between these hills, on the north end of the lake, was a plain of one or two acres, but a few feet higher than the surface of the water. This plain, perhaps twenty rods north of the pond, terminated in an abrupt descent of about one hundred feet, and then more gradually to the level of Mud Pond. Lond Pond was supplied with water by a stream of small size flowing into it from the west.

On the south, through a channel a yard in width, the water of the pond flowed out toward the southwest, forcing its passage among rocks, bushes and trees, and forming the head waters of the Lamoille River. The northern shore consisted of a narrow belt of sand and a bank of light sandy earth. Here had been formed a deposit, resembling frozen gravel, two or three inches in thickness, and extending into the pond for five or six rods from the northern shore. This deposit formed the only solid barrier to the waters—alone preventing them from descending into Mud Pond. The bottom of Mud Pond was a mass of thick deep mud, which was very solid when dry. Barton river, its outlet, flowed very rapidly for two miles, through a rough uneven territory, and then more gradually to Barton village, three miles further north. The country was covered with an unbroken forest, except where grist and saw mills, owned by a Mr. Wilson, had been erected. Some clearings had been commenced near the stream in Barton. Other mills had been erected some miles below on this stream, after its union with another stream, near Crystal Lake or Lake Beautiful, some miles below. The stream where Wilson's mills stood, was insufficient for those mills during the dry season. The inconvenience resulting from this circumstance, occasioned the proposal to cut a channel from Long Pond toward Mud Pond, and thus increase the water in the latter and the stream which flowed from it.

The inhabitants of Glover and adjacent towns interested in the matter, assembled in large numbers at Keene Corner on the 6th of June, 1810, and from thence proceeded to the northern shore of Long Pond, and commenced digging a channel, through which was to flow the water considered so necessary for the comfort of the inhabitants on the banks of Barton River. The channel or trench was commenced about three feet from the waters of the lake, and descended to the point where the descent was rapid towards Mud Pond.

When all was ready the connection with the pond was effected by removing the barrier which had been left, and the water issued through the opening with only moderate force; but to the surprise of the workmen it did not follow the channel dug, but descended into the sand beneath. It appears they had not observed that under the deposit of "frozen gravel," or hard pan, was a species of quicksand, and the stream, sinking through the broken deposit, began to wash away the sand. In a short time so much sand was carried away, thereby weakening the hard pan, that the pressure of the water widened the channel into a deep gulf, down which a large stream rushed towards Mud Pond. The workmen, now becoming alarmed, retreated to a safe distance from the constantly increasing stream, though some barely escaped.

The waters having finally demolished the hard pan, which, with the quicksand, had held them, *rushed with impetuous force towards Mud Pond,* tearing up and destroying whatever impeded their progress, and leaving but a yawning chasm and wide-spread desolation behind.

In their course they excavated a channel nearly one-fourth of a mile in width, and from eighty to one hundred feet in depth. With such rapidity did this immense body of water pursue its wild flight, that but a few moments elapsed before Long Pond had wholly disappeared from its bed. Rushing down through Mud Pond, tearing away part of its barrier, and gaining additional strength from its tributary waters, the torrent swept down the channel of Barton River, and made a rapid descent toward the meadow lands in Barton. Through all this distance it tore up the forest trees, and bore them onward as trophies of its power, while huge stones were moved from their places, and carried often a considerable distance by the force of the torrent.

The path hollowed out by the waters was thirty or forty rods wide, and, in some places, from twenty to sixty feet in depth. Not only were the mills swept away, with the mill-dams, but the ground for many feet around, and even the bed of the river, which was left to choose a new channel for itself. As the mingled mass of water, sand and timber, reached the more level country, it expanded itself, but still marched onward in its devastating career. Not only were the largest trees torn up, but vast masses of earth on the higher lands were borne onward by an immense force. Many trees of the largest size were overturned, while some were left standing in every variety of position.

So powerful was the force of the torrent, that after a course of seventeen miles, a huge rock, estimated at one hundred tons in weight, was moved several rods from its bed.

All the mills on Barton River were carried away, but no lives, so far as known, were lost in this sudden "stampede" of the waters of Long Pond to mingle with those of Lake Memphremagog.

It should be regarded as very providential, that the waters of this pond were thus let off, before the valley of Barton River became thickly settled, as they must certainly have escaped from their bed at some time, and the amount of damage would have been vastly greater had this event occurred a few years later.

For many years it was supposed the meadows were entirely ruined, being covered with sand, gravel and timber, from two to twenty feet deep. But now it is found these meadows were benefitted, rather than injured.

In a part of Long Pond, and in Mud Pond, were immense quantities of sphagnous muck. This was carried forward and mixed with the soil and sand deposited on the meadows, which now yield large quantities of grass, and in many instances are ploughed for corn and grain.

BRIEF REPORT ON THE GEOLOGY OF PLYMOUTH.

BY A. D. HAGER.

At the commencement of the publication of this work, it was contemplated having a full Report of the Geology of this town, and the writer of this had assigned to him this duty. But in consequence of the increased size of the Report beyond what was expected, and as the essential facts relating to the geology of the town have been already enumerated, it is thought advisable not to have a lengthy report upon its geology. From the elaborate reports in the scientific portion of the work, as well as the frequent allusions to the mineral wealth of the town, in the economical department, it will be seen that very few, if any, towns in the State possess such a variety of mineral wealth, or abound in objects so replete with instruction, or so full of interest as those in Plymouth. Drift phenomena are abundant and interesting. Terraces of considerable magnitude, lateral and terminal moraines, drift and glacier striæ, old river beds, extensive erosions, — the extent of some of them being definitely fixed, by the existence of pot-holes 342 feet above the valley, upon the mountains, — are all found in great perfection in this town. Here, too, tertiary deposits, embracing brown hematite, kaolin, quartz sand, and manganese, are found of considerable extent. Metamorphism may be studied in this town to better advantage than in any other place which we have seen. Upon the western side of the ponds, beds of conglomerate rock abound, in which may be seen pebbles, imbedded in a chloritic matrix, that insensibly pass into the talcose schist, the rounded pebbles gradually becoming flattened as though they had become *softened* and been subjected to powerful pressure. The flattened pebbles gradually spread out as the beds approach the north. At the distance of one mile from the spot where conglomerate rock abounds in great perfection, and to the north in the same beds there may be found a rock which usually would be denominated talcose schist, in which there are apparently interstratified beds or seams of quartz. But no practiced eye would fail to discover by tracing these conglomerate beds that what appear to be seams of quartz amid strata of talcose schist, are in fact but the flattened pebbles of quartz that once helped to form the conglomerate from which the talcose schists were derived through the agency of metamorphism.

By referring to the geological map of Plymouth (Plate XVIII), it will be seen that there is an alternation of talcose schist and limestone near the junction of the schist and the gneiss, and in the vicinity of the tertiary deposits. It is from these beds of impure limestone, or from some of them, that the material of which the beds of hematite are composed was obtained. The weathering of the edges of some of these limestones give unmistakable evidence of the existence of an ore of iron in them, which, by decomposition, becomes the oxyd of iron — the material composing brown hematite.

In the limestone region of the north-western portion of the town there are two caverns, near each other. The first is quite extensive, having in it some six or seven apartments, the largest of which is about thirty feet long, twenty feet wide, and fifteen feet high. Many persons visit this cave, and it well repays such for their trouble. Stalactites and stalagmites were once quite abundant in it, but now are mostly carried off by those who have visited it. Incrustations of limestone, recently formed and now forming by the water that trickles down the walls, are quite abundant, and some of the mammillary varieties are quite interesting. West of it, a few rods, there is another small cave, which is rarely ever visited in consequence of the difficulty found in getting into and out of it. They are situated upon a hill-side, not far from the highway passing up Black River valley. They were evidently formed through the agency of running water, assisted by the rapid decomposition of the limestone in which they are situated.

Upon the map it will be seen that much limestone is found in the town. Along its line of outcrop lime-kilns abound, which annually furnish large quantities of superior lime. For making mortar, if properly used, none can be found superior to the Plymouth white lime. Some of this limestone has been sawed and used for marble, a portion of which is found to be one of the most durable marbles found in the State. It is of a mottled-gray color, of fine texture, and, although quite hard, is worked smooth with comparative ease, and receives an excellent polish.

Beds and veins of specular iron ore, of considerable size, are associated with the impure limestones of this town, and in some cases so abundant as to be worked for ore. The localities will be seen by referring to the Map.

Carbonate of iron occurs quite abundantly, in the southeast part of the town, on the land of W. T. Merrill. Soapstone is found on the "Society Lot," near the southeast part of the town, and also on lands of Martin Pelton, Alanson Bates and Jared Marsh, Esq.

Serpentine of excellent quality is near the Five-corners and contiguous to the gold diggings on Gold Brook.

Granite is found in bowlders at the Notch, and *in situ* about two miles north of it upon a hill not far from the north line of the town.

No town in the State has furnished so much native gold as Plymouth. It is found in all the alluvial deposits in the eastern part of the town, and to many of the miners it has proved quite profitable. Its location may be seen by reference to the Geological Map of the town.

Black River rises in the north-western part of this town, and there is a circumstance connected with it rather remarkable. Several springs, far up the mountain, issue from the ground, and form a small brook, called Split Brook, which is the main stream emptying into Black Pond from which Black River takes its rise. In its course down the side of the mountain, Split Brook strikes against a rock that divides the stream, one-half of which runs to the north, after reaching the foot of the mountain, and helps to form Otta Quechee River, while the other runs to the south into Black Pond. Black River runs south in a line with the rock strata, as far as Ludlow village, and along its banks are seen numerous outcrops of limestone. During the season of low water the stream disappears in the vicinity of Plymouth Cave, and after running several rods through the fissures in the limestone, again appears at the surface.

Black River passes into, and helps to form Plymouth Ponds — two beautiful sheets of water, each of which is about one mile in length. Between these ponds there is a conical hill, composed of gravel and numerous water-worn rocks and small bowlders. It appears to be unmodified drift, and doubtless is a terminal moraine, left there during the glacial epoch.

A view of these ponds and the intervening moraine may be seen in Plate XXXVIII. A dam has been built across the stream that unites these ponds, and mills are built there as shown in the Plate. At the base of a sloping hill, upon the west of the pond, may be found the beds of conglomerate rock, alluded to in this chapter and elsewhere in this Report as occurring in Plymouth.

Soltudus Mountain forms the high background of the picture, and it is near the base of this, and north-east of the upper pond that the quarry of beautiful mottled marble is found. By reference to the map (Plate XVIII), it will be seen that the strata curve to the north of the pond, and run nearly north-west and south-east. This furnishes good evidence in support of our theory that the valley of Black River from its source to Ludlow village, is one of erosion, and that the occurrence of limestone beds gave rise to the existence of the valley. In the view given it will be seen that the valley is not continuous in line with the ponds, but is cut off at the north by the interposition of Soltudus Mountain. At this point the valley runs north-west and south-east, corresponding with the strata, but soon changes its course and runs nearly in a northerly course, to the town line of Bridgewater.

This and other deep eroded valleys, and the numerous transverse gorges that occur, render the scenery of the town bold, beautiful and picturesque. To the geologist there is here afforded ample opportunities for study, and the lover of the beautiful in Nature meets upon every side with objects of interest and admiration.

PART IX.

ECONOMICAL GEOLOGY OF VERMONT.

BY ALBERT D. HAGER.

INTRODUCTORY CHAPTER.

On entering upon the discharge of that part of our duty relating to the Report upon the Economical Geology of the State, there is awakened a consciousness of the responsibility and the magnitude of the undertaking. Had years been devoted to the examination of the mineral resources of the State, and records of the important facts relating to them been carefully kept, and brought forward as the result of such examination, the intelligent citizens of Vermont might well expect, in a State so justly celebrated for the extent and variety of its mineral wealth, to have presented to them a Report replete with interest and instruction.

But when it is remembered that the labors of those heretofore engaged in the work were suddenly cut off, ere they had reported the results of the investigations made, and that this Report is the result of examinations commenced less than three years ago, it will hardly be expected that a very thorough examination could be made in that time, upon a State which contains over 9000 square miles; and hence it must be comparatively devoid of interest, and imperfect. So many calamities have attended the Survey, in the loss of those engaged in prosecuting it, also in the burning of many of the maps and field notes, and all the specimens collected for the State Cabinet, that, to the superstitious, it would seem that a fatality was attending it. It was deemed best, by all engaged in the work, to push it to a rapid completion, and bring out the much talked of Final Report, believing that due allowance would be made by the intelligent citizens of the State, for the many imperfections that must necessarily abound in a work thus hurriedly brought out, and one requiring so much research and disciplined thought.

In order to expedite the work it was arranged at the commencement of the second season, that each one engaged in the work should have his own peculiar department assigned, in which to labor, and in that arrangement it was determined that my Report should relate to the Economical Geology.

Hence, with that view, during the last season, my attention was more particularly directed to the examination of those substances which may be made subservient to the Arts, and which have a pecuniary value attached to them. In attempting to make this classification of the rocks and mineral substances of the State, it was found that very few, if any, of the rocks could be excluded from this class. Even those ragged and towering ledges, which are looked upon by the thoughtless, as nuisances, made merely to hold the world together, not only add boldness and a charm to the beauty of the landscape, by the stateliness of their figure, and the wild beauty of their outline, but they have, locked up within them, those fertilizing elements so necessary to produce that luxuriant greenness of vegetation which is everywhere so noticeable in Vermont, and which no State in the Union surpasses.

No State of the same extent in New England, equals Vermont in the amount of its agricultural productions. The soils, although varying materially in their structure and composition, are invariably such as are favorable for the growth of grass; and the rocky hill-sides, which would fail to remunerate those who would attempt their cultivation, afford excellent pasturage, and, unlike the sun-parched pastures of our sister States, the very hill-tops, as well as the valleys beneath, have in midsummer a greenness which forcibly reminds us of the peculiar appropriateness of the name *Verd Mont.*

But as that portion of the Report, which relates to the Agricultural Department of the Survey, was assigned to the Rev. S. R. Hall, we shall not attempt to show the relation that is found to exist between the soils and the rocks, and shall only allude to the fertilizing influences of the rocks incidentally, and in connection with the other valuable qualities which they may possess.

Within the State there is found a great diversity of rock and mineral wealth. Three distinct ranges of slate, suitable for roofing, are found to extend nearly half the entire length of it, while granite of fine texture, and easily worked, abounds in the northeastern and eastern portion. Mica schist, talcose schist and gneiss are each valuable for flagging stone and fencing materials; while the marbles, slates and soapstones are not only valuable for home consumption, but yield an annual income of thousands of dollars to those who have perseverance and hardihood to unlock this great storehouse of nature, and take from thence some of its valuable treasures.

An examination of the principal quarries in the State has been made, but in many cases it was done very briefly and in but a few cases has an attempt been made to trace the connection existing between remote quarries; therefore but an imperfect view of the extent of mineral wealth can be presented. Had the appropriation been adequate, and time enough given to perfect the work, it is but reasonable to suppose that nearly all the valuable beds of rocks, possessing intrinsic value for agricultural or architectural purposes, as well as those valuable in the arts, would have been traced out, and the exact limit and position of each fixed with certainty upon the Geological Map. In the hurried manner in which this Report is brought out, such a result can hardly be expected; but it is to be hoped that the light which may be shed upon the subject, as the result of the present Survey, may lead others to carry out in detail some of the suggestions that may be made, and aid in guiding future explorations and examinations in a direction that will terminate in satisfactory results.

Our aim shall be not merely to point out and describe the localities of mines and quarries that may have been discovered, but also to show the folly of searching for mineral wealth in places where science has demonstrated the impossibility of its existence.

There are those in the community who are ever ready to engage in enterprises that claim to lead to the development of mineral wealth — indeed, it sometimes appears as if people

were seized with a mania to dig for hidden treasures, whether it be in the form of "Kidd's money," "a splendid marble quarry," or a "valuable iron mine." There is scarcely a mountain peak in the State that has not in it some reputed hidden treasure: Old Lead Mine, Silver Mine, &c. — with a legend connected therewith, that years ago — but generally beyond the memory of the "oldest inhabitant"— an old Spaniard, Indian, or hunter used to go and replenish his stock of milled dollars, or get lead for bullets by cutting it off with his hatchet, and the like foolish and unreasonable declarations; and, strange to say, all these marvelous traditions have advocates and firm believers.

As the result of this crazed state of mind, there may frequently be seen deep pits, like wells, either dug in the ground or blasted out of solid rock; and in other cases, horizontal drifts are made in hills, resembling, in many cases, miniature railroad tunnels, at the end of which, it was anticipated, lay a fortune to all concerned; but instead of that, disappointment and loss were the result.

It is curious, yet painful, to observe with what tenacity a visionary schemer, who has supposed that a fortune was buried and in store for him, adheres to his preconceived opinions. No argument can convince him of his erroneous judgment: and approaching destitution and bankruptcy are, generally, the only potent influences that can induce him to desist and abandon his unprofitable undertaking.

Fruitless attempts have also been made in the State to obtain salt water and coal.

If the amount of money expended in fruitless researches for coal, iron, and the precious metals, were counted together, it would give a sum much larger than all the profits ever realized in the State by the working of metals.

While we shall not be able to point out with certainty the location of the mineral wealth of the State, it will be our aim to disabuse the minds of those who are so sure that coal, salt water, and the precious metals are scattered indiscriminately throughout it.

For the habitual money digger, whose frenzy is engendered by the fortune teller, and who is lured on by "mineral rods," there is little hope of a permanent cure, so long as he has the means in his power to prosecute his wild schemes; but to those who claim to be actuated by a "reason why," we hope to be able to present facts which may serve as a beacon light to guide in prosecuting investigations, and determining upon the mineral character of any portion of the country.

Remark. The manuscript for the Introductory Chapter, and much of the following Report, was written and submitted to the Legislature of Vermont, in 1859. As has been suggested, this manuscript has never been read and compared with those of the other writers, and since the foregoing sheets have passed through the press, it is found that there are some slight discrepancies between the opinions advanced and those in the manuscript for the following Report. The repetition of several facts that are incorporated in the elaborate Reports already printed, also occurs, but as each writer is alone responsible for his work and the opinions expressed, and as it would detract much from the interest of the Report to omit many facts or conclusions that are legitimately connected with the subjects under consideration, it is deemed best, by the writer, to submit the Report as originally drafted, and abide the consequences — omitting only those portions of the manuscript upon the Economical Geology which are found to be repetitions of what is already printed.

GRANITE AND GNEISS.

Granite is an aggregate rock—formed of the simple minerals, quartz, feldspar and mica—presenting on the weathered surface a granular structure, and at a fresh fracture a sub-crystalline appearance. Its color is various, owing to the diversity of color of the component parts forming the rock. The granite of Vermont is usually a grayish-white. But there are some exceptions. That found in Craftsbury is a dark gray, in consequence of the superabundance of black mica found in it, while that found in Londonderry and on Ascutney Mountain is nearly white, owing to the sparseness of mica in its composition.

Occasionally seams of granite, nearly white, are found traversing beds of granite of a darker color, and it not unfrequently happens that white granite veins, composed chiefly of feldspar and quartz, are found in the silicious limestone of Eastern Vermont. The grains, composing the granite, vary in size from that of a pin's head to those an inch or more in diameter. Of the latter kind, that found in Stamford, being a very coarse variety, forms an example.

When hornblende takes the place of mica in granite, the rock is called syenite; and a stratified rock of the same composition is called hornblendic gneiss. When granite is found composed of but two minerals, feldspar and quartz, as that found south of Bradford village and extending south into East Fairlee, it is called binary granite. Porphyritic granite is that variety in which are found large and distinct crystals of feldspar; and when the feldspar occurs in slender crystals, meeting each other at various angles, somewhat resembling written characters, it is called graphic granite.

Nodular granite is found in Craftsbury, and has in it distinct concretions of black mica, nearly globular, and varying in size from a rifle ball to those two inches in diameter.—Protogine is a name applied to granite where talc takes the place of mica.

Gneiss is composed of the same material as granite, but differs from it by having a distinctly stratified, slaty or laminated structure. Although there is generally a marked difference in the structure of granite from that of gneiss, yet cases occasionally occur where it is very difficult to decide whether the rock be stratified or not. Even those rocks which all geologists concede to be granite—those of Barre, Dummerston and elsewhere in the State—when being worked, evince such a disposition to split in certain directions, that the workmen generally regard them as stratified rocks, the strata corresponding with the "rift," or cleavage planes.

We have neither a desire, nor an intention of entering into a discussion whether granite is a stratified rock, a metamorphic rock, or one of igneous origin, for that has been fully discussed in the scientific department of the Report. That the cleavage is much nearer perfect in some directions than in others, is a well established fact, and intelligent quarrymen working upon granite are as careful to determine the direction of the "rift," as those engaged in quarrying slate. It is found that granite can be split in a line at right angles to that of the "rift," or cleavage, but rarely, if ever, in a diagonal direction. In securing pillars, posts, or slabs of granite, where great strength is required, care should be taken to have the length correspond with the planes of cleavage, and not *across* them, for they are much more readily parted in the latter than in the former direction.

Except in the north-eastern portion, embracing nearly the whole of Essex Co., granite is met with only in isolated outcrops, either in the form of mountain uplifts, as Black Mountain in Dummerston, or in narrow belts or chains traversing the calcareous mica shist formation, as at Marshfield, Barre, &c.

In the gneiss formation, extending through Reading, Cavendish, Chester, Grafton, &c. on the western limit of the calcareous mica schist formation, the gneiss insensibly passes into granite, and in many places there are afforded excellent opportunities for quarrying granite as well as gneiss. The granite found in connection with the gneiss is usually very light colored, and of fine texture, but generally harder to work than the fine-grained granite of Barre. No place in the State has furnished so much granite, and probably there is no place in New England where a better quality can be obtained than at the quarries of Barre. The stone used in constructing the two State Houses at Montpelier were obtained from these quarries.

There are two slight elevations in the east and southeast parts of the town, occasioned by the outcrop of granite, called "Cobble Hill" and "Mill Stone Hill," upon which quarries are located. Although apparently isolated outcrops, yet they evidently belong to the same series of outcrops or belt that passes north through Plainfield, Marshfield, Calais and Woodbury. It is found, however, to be generally of a coarser quality in the last named towns; but places occasionally occur, in all of them, where good stone for buildings, underpinning stone, &c. are found and easily quarried.

Veins of quartz are often found traversing the granite in the northern part of this belt, which injures it for a building stone; for it is not readily split across these veins, and there is much more labor in fitting it to the required shape where they occur. The granite of this belt is found in the calcareous mica schist formation.

It often happens that veins of granite are found traversing the schist and limestone, and the contortions of the strata, and the zigzag lines of the granite, produce a phenomenon often beautiful and interesting to the lover of Nature. One of the most interesting cases of this kind occurs in the village of Marshfield, near the dwelling of Mr. E. Edson, and represented in Fig. 304, p. 570 of this Report. It will be observed that the veins of granite cross other veins of it, which are evidently older than the unbroken ones.—Another interesting fact connected with these phenomena is, that, between the times of the older and newer deposits of granite in the fissures of the subjacent rock, there appears to have been some convulsion or change in Nature, which produced a *sliding* of the rock formerly penetrated by the granite vein; for it often occurs that the ruptured or older vein is not found to correspond with the line of its first position, with merely the new vein interposed between the two sundered portions; but the lateral movement or sliding of the rock often removes the two portions of the old vein at considerable distance from each other, by means of the slide.

By reference to the figure it will be seen that a and a^1, and b–b^1 were originally joined, but, by the interposition of the granite vein, a–a^1, the small vein, b–b^1, became severed, and, by sliding, removed at a distance double the thickness of the interposed vein. The vein, a–a^1, was in like manner penetrated by the ten-inch vein, and the same phenomenon of a slide is observed, as was seen before. By this we are enabled to determine the relative age of the granite veins before alluded to. The small one, marked b–b^1, must be the oldest, and the unbroken one the youngest, of the three.

These granite veins traverse the slate as well as the silicious limestone of that region. In the vicinity of Marshfield the silicious limestone is more abundant than the slate, and the cases before alluded to were mostly in the limestone.

Cases are quite common in that vicinity where detached fragments of the limestone or slate are found imbedded in the granite. These pieces vary in size from that of a mere speck to blocks a yard or more in extent. These fragments are scattered promiscuously through the granite, and appear as though they had become associated with it, when the latter was in a plastic state. There is, apparently, no change produced in the limestone at its junction with the granite, and the small particles that are found in the matrix of granite have an appearance similar to the adjacent ledges from which they were evidently broken.

The only change observed in the slate is the contorted appearance of its strata. Not only are the detached fragments in the granite matrix generally found with the strata much bent, but in cases where the veins occur in the slate, plications are almost invariably found at or near the junction, and give evidence that they were in a soft and yielding state at the time the pressure was exerted upon them by the protruding granite, or the forces that rent them asunder.

The occurrence of granite veins in the calcareous mica schist is not confined to any one locality, but is common throughout the formation. The veins generally pass through the rock in zigzag lines—as often crossing the strata at right angles or obliquely, as otherwise. It is found that where granite occurs in such apparently injected veins, it is usually unfit for quarrying, especially if it pursues a zigzag direction. It is more compact and finer-grained, and very hard to work, and, in addition thereto, natural joints are usually numerous where the veins are narrow, rendering it very difficult to obtain large blocks that are sound. The frequency of the joints, in many cases, seems to correspond with the thinness of the veins.

At Dummerston there are several veins in the vicinity of Black Mountain that traverse the calcareous schist; and it is found that the narrower veins are much cut up by joints, while those two rods wide are comparatively uninjured by them. They do occur, however, in the thicker veins, as can be seen upon the north side of the mountain, on land of Levi Walker.

Between the farms of Levi Walker and S. Coughlin, in Dummerston, there is a vein of granite about twenty-five feet thick, protruding from between the mica schist, and conformable with its strata, having a strike N. 20° W., and dipping 30° E. It forms a division fence between the two farms for the distance of about fifty-five rods, and is so abrupt upon the western side as to form an impassable barrier, for man or beast, much of the distance. The outcrop forms a series of "embossed rocks," evidently occasioned by the natural joints that occur at intervals across the beds the entire length of it. By the combined action of frost and moisture, the rock near the joints was more readily disintegrated than at other points, and hence a rounded outline of each division is the result.

Did no better opportunity present itself, good granite might be obtained at this locality, which is evidently a spur from the great mass forming Black Mountain; but such an abundance of excellent quality is found on and at the sides of the mountain, and generally

occurring "in sheets," that an attempt to work at this, or other similar points in the vicinity, would be deemed impracticable. In no part of New England have we seen better granite than that found at Black Mountain. It is generally of a fine and even texture, free from seams of quartz or feldspar, of a light color, and very easily worked. Like the granite of Barre, this occurs in "sheets," varying in thickness from a few inches to several feet. The fissures forming these "sheets" are sometimes horizontal, but generally correspond with the slope of the mountain sides, and are often cut across at right angles, by joints.

The occurrence of joints in granite much facilitates the work of quarrying, and by their aid blocks of any required thickness can be obtained, and oftentimes without the additional trouble of splitting the second time. In Barre, thin sheets are obtained, and used for flagging where great strength is not required, and in some cases they are split out and used for curb stones.

As far as our observation has extended, where large masses of granite occur in the State, open joints are invariably found, and in some cases it gives to the rock a gneissoid appearance, quite likely to deceive the casual observer. In the gneiss formation, as has been observed, granite of workable quality is found, but has never been quarried to much extent, as the gneiss is generally more easily split into stone posts, building stone, &c., and for the former use it is more valuable, being stronger than granite.

In the neighborhood of the gneiss, dwelling houses, mills and factories are not unfrequently made of that rock, and the ease with which the rock is split out and fitted for the builder's use, renders quarries of gneiss valuable, and it is evident that as the wants of the community demand more durable buildings than those of wood, gneiss will come into more general use, and its value be greatly augmented thereby.

The many elegant and substantial village residences, farm houses, mills, &c., found in Chester and Cavendish, built of this rock, fully attest its beauty and value as a building stone.

Large sheets or strata of gneiss can be easily obtained at the quarries, and these can either be split across the grain into fence posts, or be subdivided into flagging stone for walks, cellar bottoms and for other similar uses. The loose bowlders found in the soil are valuable for stone walls, and little other fence is used to inclose the pastures and cultivated fields in the vicinity of the gneiss formation, especially upon the land of those considered the best farmers.

There are, in Vermont, two distinct deposits of gneiss, with the talcose schist interposed between them. The most eastern extends from Marlboro to Barnard, and the widest place about six miles wide, embracing nearly the entire towns of Grafton, Chester and Cavendish. In the latter town it is divided into two spurs, the eastern running in a northerly course through the eastern part of Reading and uniting with the gneiss and syenite of Little Ascutney, the other spur passing through the western part of Reading and eastern part of Bridgewater into Barnard. In this formation there are numerous beds of hornblende slate, mica slate, and occasionally interstratified beds of dolomitic limestone and steatite or soapstone are found near its eastern limit. The valuable beds of steatite at Grafton and Weathersfield are in this formation. The other formation of gneiss extends from Massachusetts nearly to Canada line, and forms what is known as the Green

Mountain range. It passes from Stamford and Readsboro, northerly through Somerset, Stratton, Peru, Mount Holly, Mendon, Chittenden and Ripton, and from thence takes a north-easterly course and helps to form the base of Camel's Hump, Mansfield and Sterling Mountains. At the southern part of the State it is about fifteen miles wide, but in going north it is found to grow gradually narrower till at Chittenden it is found to be only about six miles wide; and at Bolton where it is crossed by the Winooski, between Mansfield Mountain and Camel's Hump, it is less than two miles in width. Further north in Johnson, where the Lamoille crosses it north of Sterling Mountain, it can scarcely be distinguished from the talcose slate that surrounds it, and with which it insensibly unites. The gneiss just described varies in appearance from that found in other parts of the State, hence it has been appropriately called "Green Mountain gneiss."

In many cases talc seems to take the place of mica, and hence, when the feldspar is but sparsely disseminated through the rock, it is very difficult to determine whether it be gneiss or talcose slate. The strata, too, are generally very much contorted, and it is quite difficult to part them, so as to obtain a smooth surface, hence this variety is less valuable for building purposes than heretofore described.

Veins and interstratified masses of quartz are common the entire length of the formation, and in Mount Holly there are numerous dikes and erupted masses of hornblende found in it. Many suppose the Green Mountains are composed of granite; but this idea is erroneous, for but very little granite is found in the entire range.

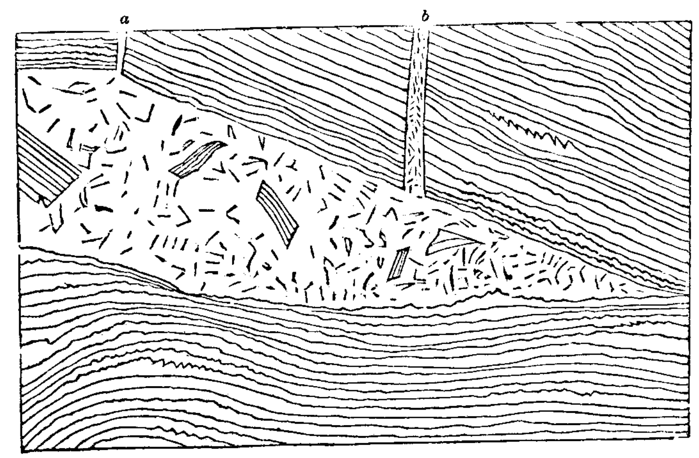
In the southern portion, the range is composed mainly of Green Mountain gneiss, with outcrops of granite in Stamford, Stratton, Peru and Shrewsbury; and in the northern parts the range is composed mainly of talcose schist, with scarcely a single exception of granite. Camel's Hump, Mansfield and Sterling mountains have summits composed of talcose slate, in which there are numerous seams and interstratified masses of quartz. As before stated, Green Mountain gneiss forms a part of the base of these mountains. This gneiss is shown where the Winooski and La Moille have cut channels through the range and exposed the rock near their bases. The strike of the rocks composing this range is N. 20° E. and forming an anticlinal axis near the center with a dip east and west from the center of the mountain.

We have seen but one case in the State where granite is found in the talcose schist formation, and that is a small outcrop about sixty rods in length, and in the widest part not more than ten rods in width, situated in the northern part of Plymouth.

For many years past, large bowlders of a very nice white granite have been found, and split up into underpinning stone, fence posts, &c., at Plymouth Notch and vicinity, but the rock *in situ* has never been worked, and its locality was known to but few, if any, of the citizens of Plymouth, prior to the time of our visiting this spot. The bowlders had evidently been transported by drift agency from their parent bed, which would be found north or a little west of north from where the bowlders were found; hence, we started in that direction to find the bed, and at a distance of two and a half or three miles found the outcrop from whence the blocks had been taken. The outcrop is evidently a protruded mass forced up through the schist rock. The strata of the schist are parted, and the intervening space filled with granite. At the south end of the outcrop the exact limit of the granite can be seen — the slate being parted and appearing above and below the granite.

The strike of the schist over the granite is N. 10°W. with a dip from 40° to 50°E. The dip of the schist below the granite is a little less than that above. The following is a view of the south end of the outcrop as seen from the west:

Fig. 323.



Granite in Talcose Schist, Plymouth.

It will be observed that fragments of schist occur in the granite. These fragments are the same as the rock in which the granite is found. The edges and corners of the fragments are not worn, but appear to have become imbedded in the matrix of granite, when the latter was in a plastic state.

Another interesting phenomenon is here exhibited. The principal mass of granite, as has been observed, is interposed between the strata; but from this mass there are several offshoots or spurs, running off at right angles, across the strata of schist (as shown in the dikes *a* and *b*, in the cut), and filling fissures that appear to have been made at the time the granite was erupted. These spurs, some five or six in number (two of which are shown in the cut), vary in thickness from one to ten inches, and form an excellent example to illustrate the point before named, that in thin veins the texture is finer than that found in larger masses. It is a noticeable fact that joints are more numerous in the thin spurs that shoot off, than they are in beds of greater thickness.

The abundance of other workable rock in the State, may be the reason why so few granite quarries are opened and worked. In the north-eastern and eastern portions of the State, where schists and limestones are not abundant, granite is quarried in several places, and blocks obtained for architectural purposes, but in no place has systematic quarrying been established and successfully carried on.

The occurrence of workable granite of superior quality being so common in the State, it seems desirable that efforts be made to bring it into notice. In many instances, in the construction of buildings, persons have gone abroad to obtain granite, when an abundance was near at hand, but not being quarried was lost sight of, and considered valueless.— The stone used for the new Court House at Windsor, was found in New Hampshire, and transported over two railroads, while the beautifully mottled syenite and white granite of Ascutney lay untouched, almost in full view from the building. No syenite is found in the United States of better quality or more beautiful than some of the varieties of Ascutney

Mountain. A beautiful specimen may be seen in a monument erected by Dr. Chamberlain in the Cemetery at Cavendish, which stands uninjured by the weather, although exposed to it several years. Granite of various degrees of fineness is abundant at Ascutney—a very large proportion of it being too coarse to be valuable for architectural purposes, but near the junction of granite and the other rocks it is usually fine-grained and of good quality. In looking upon the granite of Ascutney—and indeed on much of the granite of Eastern Vermont—we find it invariably of a coarse quality where it occurs in large quantities, but when found of limited extent, or contiguous to other rocks, it is almost invariably of a fine texture. In this respect it resembles cast iron, the *chilled* specimens being fine-grained and hard, while the same metal if cast into "pigs" and suffered to cool slowly is comparatively soft and coarse-grained.

It would be no small task to enumerate all the points from which good granite could be obtained, and we shall not attempt it, but give some of those localities remote from the granitic regions found in north-eastern Vermont.

At Stamford there is found a variety of a dark color, and generally too coarse-grained to be valuable or easily worked. But doubtless upon the margin of the outcrop, or in small spurs shooting off from the main body, there may be found fine-grained and valuable deposits.

Near Cuttingsville there is a hill of granite where are afforded good opportunities for obtaining blocks. The rock upon a fresh fracture has a greenish color, which turns white upon long exposure. Blocks for culverts upon the Rutland and Burlington R. R. were obtained at this locality; but aside from these, very little has ever been quarried here. Upon the eastern slope of the hill we think the rock too much cut up by joints to afford large and sound blocks, but upon the southern and western slopes good opportunities are presented for obtaining large blocks that are sound.

Allusion has already been made to the granite of Black Mountain in Dummerston.—The granite of which this mountain is composed is very white, and much of it is fine-grained and very easily worked. Granite is rarely found that splits as evenly and with the same facility as that found around this mountain.

Berlin produces some of the finest grained and most valuable granite anywhere to be found. The Principal of the Survey gave evidence that he thought highly of it, by ordering parties in Montpelier to make him a family monument from this rock.

Chester and Cavendish furnish good white granite, that is found associated with and insensibly passes into gneiss. Very little has been quarried—only what has been wanted for home consumption.

In the south-east part of Pomfret an outcrop occurs which has been quarried a little, most of the stone taken therefrom being used in Woodstock, about five miles distant. It seems to have been forced up between the strata of mica schist, being about one mile in length, and from fifty to seventy rods in width. The bed runs nearly north and south, and in some portions of it there appear to be stratified masses in which are found numerous folds. Numerous other beds occur to which allusion has already been made in the preceding part of this Report.

FLAGGING STONES.

Rocks suitable for flagging, underpinning and building stones are quite abundant in Vermont, and although but comparatively few flagged walks are seen in the thriving villages of the State, yet the reason is not to be attributed to the absence of material necessary for their construction, or to the dilatory habits of the people, but perhaps to the fact that in most parts of the State gravel banks abound from which material can be obtained for making excellent walks at a less expense than stone.

The most abundant and accessible supply of flagging stone is to be found among the gneiss, schistose and slate rocks of the State, and in the vicinity of these we can hardly name a spot where good flagging stones may not be found. One of the best localities is in the gneiss of Cavendish. Large, smooth tables of gneiss, from one to ten inches in thickness, may be obtained in the Duttonsville Gulf and loaded upon the cars directly from the ledges. No systematic quarrying has ever been carried on at this place for flagging stone, but large quantities have been removed at different times and used in the construction of buildings and for underpinning stone, cellar bottoms, stone posts, &c., &c. The same quality of rock, that in many places can be easily quarried, is found in Chester and elsewhere along the whole line of gneiss outcrops.

Large and shining slabs of talcose and mica schist are found along the formation in many places and answer well for flagging, the only objection being in the slippery nature of the talcose rock.

Much of the overlying slate removed in opening quarries, and slabs not suitable for roofing slate, if a little pains were taken, would answer well for flagging, and we notice such slabs are being used in Rutland and elsewhere.

In the palæozoic rocks of the Champlain Valley occasional opportunities are presented for obtaining good flagging, but the rocks are usually too thick-bedded to answer well for that purpose. The best places are usually near the lake shore along the terrain of Trenton limestone. A locality of this kind, and one of the best which we have seen, is upon Grand Isle at Rockwell's Bay, near the house of L. E. Ferris. At this place the Trenton limestone occurs in thin sheets, separated by seams of shale, and lying nearly horizontal upon the shore of the lake, and so situated that the stone could be loaded upon a vessel directly from the quarry.

Notwithstanding the numerous localities of good flagging stone in the State, comparatively few of them have ever been worked, and none of them extensively, probably for the reason that any man who wants flat stones can readily find them if he lives on the line of the metamorphic schists. The foreign demand has not been such as to warrant the opening and extensive working of quarries of this kind.

WHETSTONES.

Talcose schist, with which there is associated a limited amount of silex disseminated in small grains, is found to answer well for whetstones,—better, indeed, than rocks in which silex forms the principal constituent. A variety of rock denominated whetstone slate extends over large portions of the State; but the variety best suited to the manufacture of whetstones is restricted to comparatively narrow limits. The most common occurrence of the valuable varieties are near the junction of the talcose and clay slates. This includes not only the variety of which scythestones are made, but also the kind called

NOVACULITE.

Upon the skirtings of the clay slate of Guilford, extended ledges of novaculite are found. We are not aware that any has been used for hones at this locality, but doubt not good specimens for that purpose could be readily obtained in large quantity. But the most extended range of the rock is found bordering upon the clay slate extending from Northfield to Memphremagog Lake. Much of the distance novaculite is found, but it occurs in the greatest purity in the northern portion of the outcrop near Canada line.—The "Magog Oil Stone" so valuable for razor hones, is but another name for this stone.

Several years ago a quarry was worked upon a small island — Fitch's Island — in Lake Memphremagog, and large quantities of hones were made, for which there was found a ready market.

The strata from which the stone was obtained were below high water mark, and hence the quarrying was attended with much inconvenience from water, and for this and other reasons the quarry is not worked. Other points south and west from this locality doubtless afford opportunities superior to those found on Fitch's Island for obtaining the material for hones.

SCYTHESTONES.

Several localities of silicious talcose schist are found in the State where scythestones of excellent quality are found — prominent among which may be named the quarry of the Messrs. Belknaps, of Northfield, and that of Abel Adams, of Ludlow. The quarry in Northfield is situated near the junction of the talcose schist and clay slate, and about three-fourths of a mile north-east of the village. Near the quarry is a mill with the appliances for sawing and finishing the stone. Three men were employed at the time of our visit, and we were informed that the sales amounted to about 3500 dozen per annum.

Specimens of the scythestone, and cubical blocks of the stone from which they are made, are upon exhibition in the State Cabinet.

The quarry of Abel Adams, in Ludlow, is near the south line of the town, from whence the stone are taken to a mill near his dwelling about a mile distant. The stone finished here are of superior quality, and command a price as high as any stone in market.

In the south part of Stockbridge there is a quarry from whence rock has been taken and manufactured into whetstones. Numerous other localities exist in the State, where materials for good scythestones could be obtained if the demand for the article was sufficient to warrant an investment adequate to carry on their manufacture.

SAND.

This indefinite term is applied to any hard mineral substance that occurs in a granular or pulverulent condition. It is usually the result of the disintegration of granitic, quartzose or crystalline rocks, and is found in beds forming terraces or sand banks, or in the more recent deposits along the banks of rivers, or in the beaches that skirt larger bodies

of water. In some countries large areas are entirely covered with sand, forming barren tracts called deserts.

Sand necessarily partakes of the nature of the rock from which it is derived, hence along the western base of the Green Mountains, in the vicinity of the quartz rock, silicious sand of great purity, and a snowy whiteness, is found, while the sands upon the shores of Lake Champlain, derived from the crystalline rocks of the Adirondacks, are gray, and oftentimes shaded with black or reddish-brown, in consequence of the numerous particles of specular iron or fragments of garnets that are associated with them.

Upon the shores of the lakes and ponds in the granitic portions of north-eastern Vermont, spangles of black mica are usually associated with the quartz grains that form the sand. This is valuable not only for making mortar, but when applied to white paint to give a hard finish, it forms a durable coating and a good imitation of granite.

Sand is subservient to the arts in many cases, and in some instances its use seems indispensable. Without sand, which fortunately is always to be found in the vicinity of Eolian marble quarries, we cannot imagine how marble could be sawed into slabs, or easily be smoothed down to a plane surface, nor could we well find a substitute for it in making mortar, hydraulic cement, or for the uses to which it is applied in a foundry. Sand is extensively used in the manufacture of glass, the impure varieties producing the dark bottle glass, and the white variety the transparent flint glass. The "Brooklyn Flint Glass Co." own an extensive and valuable bed of arenaceous quartz on land of Joseph Sexton, in East Dorset, from whence are taken large quantities to the glass manufactories in Brooklyn, N. Y.

Other beds of white sand are found on land of Daniel G. Williams and elsewhere in the vicinity, and from their appearance it is evident that they resulted from the decomposition or disintegration of solid quartz rocks that once occupied their places. In some instances there are intercalated masses of quartz not wholly disintegrated between the strata of sand, but these usually crumble upon exposure to moisture and the atmosphere.

Beds of disintegrated quartz rock are found in Shaftsbury, not far from the residence of Hon. Norman Millington, in which the fossil *Scolithus linearis* is very abundant in its undisturbed position, but so fragile that it is quite difficult to retain it for cabinet use, when detached from its matrix.

Beds of sand, of a similar nature, are found associated with nearly every bed of kaolin in Western Vermont and at Plymouth. It is from beds of this kind that the quartz sand used in the manufacture of fire brick at Brandon and Bennington is obtained.

From an inexhaustible bed, associated with kaolin at Tyson's Furnace in Plymouth, large quantities have been removed and used for molding sand. The purest varieties found are very valuable in the manufacture of porcelain, and white earthern and stone ware. But aside from every other use to which sand is applied, it would prove very serviceable if judiciously used by the agriculturist. Stiff clay soils are much improved by heavy top dressings of sand, as they thereby become more porous, and air, heat and moisture are more readily communicated to the roots of plants.

But the most apparent advantage derived from the application of sand is upon reclaimed peat or muck meadows, or upon such lands as have a superabundance of vegetable mold, and are nearly or quite destitute of silex, one of the principal constituents of sand.

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On such lands grain, although it often attains a luxuriant growth, rarely ever ripens without *lodging*, for in the absence of a sufficient amount of silex in the stalk, it is unable to support itself and withstand the buffetings of wind and storms.

Beneficial results attend the mixture of sand with soils of this character, for the silica from the sand enters more largely into the composition of the stalk and gives it mechanical firmness sufficient to sustain itself till the grain ripens.

Now when it is known that over seventy per cent. of the material composing the stalk of wheat is silica, how foolish it would appear, and how futile would be the attempt to try to raise wheat upon a soil in which there was no silex, or where as sparingly found as it is in muck beds, or in soils composed mainly of vegetable matter, from which heavy draughts have been made upon the soluble silica by successive crops.

Sand applied as a top dressing is rendered more soluble by the mixture of ashes or lime, and hence when the latter is used in connection with the sand, the desired results more readily follow the application.

LIMESTONE.

Limestone, when found in a pure state, contains about 56 per cent. of quicklime, and about 44 per cent. of carbonic acid. When brought in contact with strong acids, effervescence will be produced by the rapid expulsion of carbonic acid gas. For economical purposes, limestone is subjected to great heat in kilns prepared for the purpose, by which the carbonic acid is expelled and the caustic lime produced. This has a great affinity for water, and if not supplied from other sources will become the hydrate of lime — or *slaked* — by the vapor contained in the atmosphere, in which case it is called *air-slaked lime*. When properly slaked with water, and made into a plastic mass with silicious sand, it forms mortar, which upon drying becomes hard, the lime forming a cement by which the grains of sand are united. It may be proper here to remark, that when hard and durable mortar is wanted, care should be taken to secure clean silicious sand that is pretty coarse, and for one measure of lime from three to seven or eight measures of sand should be used. It is a mistaken idea that a superabundance of lime adds to the compactness and strength of the mortar, for the reverse is true. Just lime enough to form a cement to unite the particles of sand and hold them together when being used is all that is necessary.

We often meet with "pudding stones"— masses of fine pebbles and sand, united by a calcareous cement that was deposited by water charged with the carbonate of lime, or lime and magnesia,— and they usually excel in hardness any artificial combination of sand and lime. Why not copy from this example in nature?

The uses to which quicklime is applied are many and varied. It is used to clarify the juice of sugar cane, and to generate heat and absorb the volatile gases in a compost heap; to purify the coal gas that illuminates our cities, and to bleach the rags of the paper-maker and the cotton and linen fabrics of the manufacturer; to render potash and soda caustic in the soap manufacture, and used in water to restore health to the invalid; to free the hide from hair in the tanner's vats, and when mixed with litharge to dye the gray whiskers of the bachelor; to stop the stench that might arise from the slaughter-house, and to aid the chemist in his researches; and were the soil deprived of it entirely, large tracts of country now supporting luxuriant vegetation would become desolate and barren wastes.

This valuable product is scattered with beneficent profusion throughout the State, for there is scarcely a town in which it is not found, either in a state of comparative purity, or in combination with other rocks.

As the result of this extensive distribution, may be found the reason why soils, apparently destitute of vegetable mold, are so productive, and continue to be after successive crops have been taken therefrom. Lime is found associated with, and occasionally entering into the composition of gneiss and the schists, and its presence may generally be known by the rapid disintegration and crumbling of the rock when exposed to the weather.

Except upon the rich alluvial meadows, no portion of the State is so fertile as that upon the limestone of western Vermont, and upon the calcareous schist formation. In the latter, interstratified beds of silicious limestone are abundant, which, upon exposure, become decomposed, the lime entering into and giving strength to the soil, while the silicious portion, which at first forms a granular crust around the solid rock, gradually crumbles, forming a warm soil capable of sustaining good crops of grain, with silex enough in the culms to prevent it from lodging.

The lime is not confined wholly to the beds of silicious limestone found in the calcareous schist formation, but enters into the composition of the schists themselves, and oftentimes in such quantity as to cause them to rapidly decompose and crumble into soil. Much of the gneiss, and especially that contiguous to beds of limestone, has lime or calcite in its composition, in which case the weathered edges crumble and help to fertilize the earth. The same is true of talcose schists, even in places far remote from dolomitic or limestone beds.

Much the larger proportion of workable limestone is found in western Vermont, in the Eolian limestone formation, and amid the Silurian rocks of the Champlain valley. For many uses, and especially for bleaching purposes, the pure carbonate of lime is much more valuable than those varieties into which silex, alumina, or magnesia enter. But for hydraulic cements, and mortar to be used in situations exposed to the weather, the impure varieties are found to be the most valuable.

There is one noticeable fact which may well be alluded to in this place. The quality as well as the appearance of quicklime depends much upon the *structure* of the rock from which it is obtained. A fine-grained limestone, of a compact texture, that splits with a conchoidal fracture, almost invariably produces white quicklime, that comes from the kiln in solid lumps, while coarse-grained and friable or porous limestones, possessing the same constituents and of equal purity, afford lime of an inferior quality, and usually of a dirty ash-color, and which upon exposure to the air soon crumbles into powder.

Some of this ash-colored quicklime is found good for mortar, but that obtained from the compact rock from the same ledge, and burned in the same kiln, is found to be more valuable even for this purpose.

Compact stone, fresh from the quarry, is more easily reduced to quicklime than blocks that have been long exposed and dried, for the reason that the moisture contained in the former when disengaged by heat, assists in the escape of the heavy gas.

When silex enters largely into the composition of the rock, like much of the limestone found in the calcareous schist formation, care should be taken that the heat be not too intense, for if too much heated, the rock, instead of parting with its carbonic acid and becoming quicklime, will be fused into a glassy substance wholly unfit for making mortar.

To undertake the enumeration of all the places from which good material for quicklime could be obtained, would be a difficult task and one which will not be attempted. Old limekilns abound in the vicinity of nearly all outcrops of limestone, but of late much of the lime manufactured is from *perpetual* kilns. These are so constructed that fuel and the rock from which the quicklime is obtained are put in at the top, and the quicklime is obtained through a door at the bottom of the kiln.

The space in the kilns containing the fuel and stone is egg-shaped, or like two truncated cones placed base to base, by which shape the material in the kiln is supported or kept up while the removal of the quicklime is being carried on from an opening at the bottom.—It is quite necessary that a good draught be maintained during the time of burning, in order that the disengaged carbonic acid gas, which is heavier than common air, be carried off— hence an orifice should be left at or near the bottom for the entrance of air.

Along the eastern base of the Green Mountains, and occasionally in the gneiss and talcose schist forming the range, there are found beds of limestone that furnish material for good lime, and in quantity sufficient to supply the demand of the community in the vicinity. These beds are usually saccharoidal, and oftentimes dolomitic or magnesian, but almost invariably furnish lime that makes a mortar that is very durable. Whether these beds, or any of them, are counterparts of the great deposits of limestone upon the western side of the Green Mountains, is a question that we do not propose to discuss in this place, but merely say that to us there is strong presumption that such is the case.

The most southern beds upon the eastern side of the Mountains of which we shall speak are found west of Whitingham village on lands of S. Atherton, J. Dix and J. Kentfield, from each of which there have been obtained material for lime. Much of the rock is white and sacchariodal, and quite pure carbonate of lime. The beds probably all belong to the same deposits, and their occurrence was doubtless the cause of the valley which extends nearly N. and S. along the line of their outcrop. The beds have a strike N. 10°W. and a dip of 25 to 40° West, the dip being greatest in the northern beds.

Other beds doubtless occur further north in the vicinity of Deerfield River in the northern part of Whitingham, and probably in Wilmington. In that portion of Somerset (the eastern) lately set off and united with the towns of Stratton and Wilmington, are found several beds of white limestone, from which lime has been obtained, among which may be named the quarries on land of George Rice and Rufus Lyman. These beds have a strike varying from N. 30° to 60° E. with an easterly dip of 40° to 55°.

Plymouth furnishes some of the most extensive beds of limestone found east of the Green Mountains. The strike of the limestone corresponds generally with that of the schist encasing it. The dip of the beds in Plymouth is invariably to the east, and generally at an angle of about 45°. We are inclined to the opinion that all these localities, and many intervening beds not enumerated here, belong to the same line of deposit, and are outliers that once were connected with the immense deposits of limestone west of the Green Mountains.

Before railroads were introduced, no town in the State furnished more lime for market, or of better quality for mortar, than Plymouth; but since that time the foreign demand has not been so great, and being six or eight miles from a railroad, other manufacturers of lime, where the kilns are contiguous to the road, have an advantage in the cost of freight, hence the manufacture is somewhat limited, as compared with former years.

Should the bed of mottled marble belonging to the Neshobe Marble Co., near the north end of the upper pond, be worked for marble, as it doubtless will be before many years, an excellent opportunity will be presented to burn lime from the fragments of the quarry, as the material forming this marble produces as good lime for mortar or whitewash as can be found in the State. For bleaching purposes, it would probably be inferior to the purer carbonates from Western Vermont, as over 44 per cent. of its composition is magnesia.

Other beds of limestone than those enumerated, exist along the eastern base of the Green Mountains, which have already been noticed, hence they will not again be alluded to in this connection.

East of the limestones already described, there is another series of outcrops in the gneiss. The most southern bed to be noticed is one owned by William Holbrook, and is near the north-east corner of Townshend on the town line of Athens. From these beds, which are interstratified with gneiss, there is obtained good material for quicklime, and there is manufactured a supply for the home market. The strike of these beds is N.E. and S.W. and in line with the soapstone beds of Grafton and the one in Townshend, having a dip 48° N.W.

Weathersfield and Cavendish have in them extensive beds of limestone, being generally in the western part of the former and in the eastern part of the latter town. Before the introduction of railroads much lime was manufactured in these towns, but recently less has been made, especially in Cavendish.

Like the beds owned by Mr. Holbrook, the beds in Weathersfield lie in a line of strata corresponding with those inclosing the steatite beds near Perkinsville.

The lime produced in Weathersfield is of a dark color, and does not produce mortar so white as many other localities; but when used in exposed situations it is found to be very durable, in many cases being nearly equal to water cement. It has been used much in the construction of railroad culverts, piers for bridges, &c., and in the railroad tunnel in Burlington this lime was used instead of water cement. We are of opinion that for hydraulic purposes it would be greatly improved by mixing with the quicklime a proportion of calcined clay in a dry state before mixing it with sand. C. Amsden and Azro Craigue, of Upper Falls, are the principal manufacturers.

In no place east of the Green Mountains is quicklime manufactured to the extent that it is upon the western side. Perpetual kilns are there erected, and the business is extensively carried on during all seasons of the year. The purest limestone is selected, and the products from the kilns are as white as chalk. Analyses of the rock show that the beds from whence most of the material is obtained are nearly pure carbonate of lime. Magnesian limestones are generally studiously avoided, as in many uses, especially for bleaching, the magnesia is found to be injurious. Most of the perpetual kilns are built contiguous to railroads, and thus the expense incident to transportation by teams is avoided.

Charles W. Rich, Esq., of Swanton, owns and works a nice limestone quarry in the southern part of the town. The rock has a strike N.E. and S.W., and dips 25° S.E. The quarry has been worked about ten years, the product of lime averaging about 15,000 barrels annually. At the time of our visit (1858) the kilns were producing lime at the rate of 25,000 barrels per annum. About twenty hands were employed, exclusive of coopers. Several years ago this same limestone was quarried and sawed for marble, producing the dove-colored or Swanton marble; but the beds were so much cut up with joints that it was very difficult to obtain large blocks, hence that enterprise was abandoned.

Near this quarry, kilns were being erected, and another quarry opened by Messrs. L. R. Brainard & Co. The material for lime obtained from these beds, like that from Mr. Rich's, was very pure, and would produce very nice white lime. Associated with the pure carbonate, there were beds that contained twenty-eight per cent. of the silicate of alumina, and one per cent. each of magnesia and the peroxyd of iron, and seventy per cent. of carbonate of lime, from which it was inferred that hydraulic lime could be obtained from it. We incline to the opinion that there is in the composition of this rock too great a proportion of lime and too little of silica and magnesia to prove valuable for hydraulic uses; but we will here remark that experiment only will satisfactorily test the question. That this impure limestone will produce lime that would make mortar more durable and harder, if properly used, and mixed with the proper proportion of sand, than that obtained from the pure carbonates, we have very little doubt, especially if it is to be placed in exposed situations. But whether it possesses the property of "setting," and would become hard under water, is a matter of conjecture, to be settled only by trial.

In Colchester, not far from the railroad, Alphonso Bates has a quarry and one perpetual kiln, from which he obtains about one hundred and fifty bushels of lime per day. The rock from which the lime is obtained is fine-grained and compact, and similar to that found in the beds at Swanton, and at Winooski a few miles further south. The color of the stone in Mr. Bates' quarry is a little darker than that from the quarry of Messrs. Penniman & Noyes, at Winooski, but the lime produced from both is equally white and valuable.

Messrs. Penniman & Noyes are probably more extensively engaged in the manufacture of quicklime than any other company in the State. They have four perpetual kilns of the most approved pattern and finish, situated very near the railroad, a short distance east of Burlington. A very great supply of superior stone is found in their quarry adjacent to the kilns, which is readily quarried, and conveyed upon tramways to the top of the kilns. From twenty-five to thirty hands are employed about the works, and four thousand cords of wood are annually consumed by them. The daily product is about seven hundred bushels, or 250,000 bushels of lime, of eighty pounds each, per annum. No lime of greater purity than the Winooski lime is sent to market. The strike of the beds in the quarry of the Winooski Limekiln Company (Penniman & Noyes) is nearly N. and S., with a variable dip from 15° to 45° E.

The Brandon Lime and Marble Company have quarries and kilns near Whiting Depot, from whence is obtained about 25,000 barrels of lime per annum. In all the departments, including coopers, about twenty-five men are employed by this company. The appearance of the lime manufactured by this company is similar, in all respects, to the varieties

last named. We here append the analyses which we find in the circular of the company, which are as follows:

BOSTON, MASS., October, 1859.

Dear Sir,—I have analyzed the sample of quicklime from Brandon Lime and Marble Company, and find that it contains in one hundred parts by weight:

Pure lime,	97.52
Magnesia,	.02
Silica,	.02
Carbonic acid,	2.44
	100.00

On slaking I find that 200 grains of lime solidifies of water 65½, making hydrate of lime 265½ grains.—This lime is the purest I have seen in this country, and is of the best quality for all chemical uses.

Respectfully your obedient servant,

To J. E. HIGGINS, *Brandon, Vt.*

CHARLES T. JACKSON, M. D., *State Assayer.*

J. E. HIGGINS, TREASURER, *Brandon Lime and Marble Co.:*

BOSTON, MASS., March 2, 1860.

Dear Sir,—I have made three analyses of the lime received from you. The following is the average result: One hundred parts gave

Carbonic acid,	.26
Silica,	.13
Lime, with traces of magnesia,	99.61
	100.00

It is the *purest* lime I have met with, and of great value for chemical purposes. For purification of illuminating gas and for soap makers, its value is one-third greater than Thomaston lime.

Very truly your friend and servant,

JOHN H. BLAKE.

This lime is sold and successfully used by the Boston Gas Light Company, where there is daily used two and one-half tons; by the Waltham Bleachery Company; the Somerville Bleachery Company; by Soap Manufacturers; at the Rumford Chemical Works; at Providence, &c., &c. The purity of the Brandon, Winooski, and Swanton lime, and its freedom from silex, from whence originates grit, render it very valuable for bleaching and other similar purposes to which it is applied.

Lime is valuable as a fertilizer, and, when judiciously used by the farmer, well repays the trouble and expense. By its use the volatile gases, so beneficial to vegetation, are absorbed and secured, that otherwise would escape from the compost heap and be lost in the atmosphere. When used in sewers and filthy pools it not only helps to form an excellent fertilizer, but deprives the atmosphere of the pestilential miasma that would otherwise engender disease and bring death to persons residing near.

MARBLE.

Marble is a name appropriately applied to those varieties of carbonate of lime, or lime and magnesia, that can be quarried in large blocks destitute of fissures, and sufficiently compact and uniform in structure to receive a good polish. It usually effervesces with acids, and when calcined affords quicklime. The saccharoidal varieties produce an ash-colored and friable variety, while the more compact kinds usually furnish white lime of good quality.

The value of marble, when found in workable quantity, depends upon the purity of its whiteness, or upon the beauty or agreeable association of color in the variegated kinds.—For convenience we will arrange the marbles of this State in four classes: The Vermont (Eolian) Marble, the Winooski, the variegated of Plymouth and the Isle La Motte. To these perhaps we should add the serpentine, which by common consent—although without good reasons—is now known in the State by its commercial name Verd-antique Marble. This classification is susceptible of many subdivisions, for an almost endless variety exists. Many varieties are often found in the same quarry. At the Vermont Italian Quarry at East Dorset there are found eighteen beds, each having its peculiar characteristics, and so strongly marked as to be readily recognized by those familiar with the quarry. The same is true of the quarries at West Rutland. The white and gray, the mottled and striped, the saccharoidal and laminated, the friable and the compact are all found in the same quarry, but each is restricted to certain "tiers," "layers" or beds, and generally continues with them, sometimes several hundred feet.

The variety of marble that has been most extensively worked in Vermont is the white granular variety. In color and structure it closely resembles the Carrara marble, the quarries of which were opened in the days of Julius Cæsar, and since then have become celebrated for the great amount of marble taken therefrom, and the many valuable blocks that they have contributed for statuary purposes.

Associated with the white granulated marbles of Vermont, there are varieties that strongly resemble the Pentelic Marble of the ancients, of which the Parthenon, Hippodrome and other edifices of Athens were made. Mount Penteles near Athens furnished this marble, and the greenish zones that begirt those ancient columns very closely resemble the green-banded blocks obtained at West Rutland. The translucent white marble of the ancients so highly prized, and so much admired for its purity of color and fineness of structure—a few specimens of which are found in the sacred altars of Venice—has its equivalent in the fine translucent marbles of Brandon and Shelburne. The grayish white marble of Mount Hymettus in Greece, has its equivalent in the dove-colored marble at Swanton; the black marble of the ancients in that at Isle La Motte; the red antique in the Winooski marble, and the Verd-antique is fully equaled in beauty and durability by the Serpentine or Ophiolites of Cavendish and Roxbury.

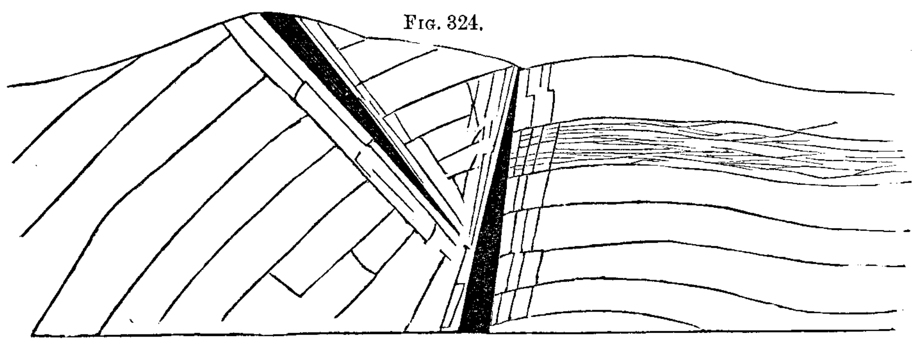
As before remarked, the marbles that have been the most extensively worked in the State were of the white saccharoidal variety, quarries of which were found in Middlebury, Sudbury, Brandon, Pittsford, Rutland, Clarendon, Wallingford, Tinmouth, Danby, Dorset and Arlington. In opening the first quarries the great desideratum was to obtain *white* marble, and a kind that was easily worked.

It may be proper here to remark, that until 1804 marble was not sawed in New England, but quarries were selected where "sheets" could be split off, which afterwards were worked smooth and to the desired shape with chisels in the hands of the workman. In the year A. D. 1804, Eben W. Judd, Esq., of Middlebury, adopted the plan of the marble workers who lived in the days of Pliny, and sawed the first marble in the State with a smooth strip of soft iron, with the help of sand and water—the plan now universally adopted throughout Vermont and other places where marble is sawed.

Beds of fine close-grained and compact marbles were not considerered valuable, and only those of a more friable nature were selected. Many of the first quarries opened were adjacent to trap dikes. Whiter marble was found there,—in addition to which, the numerous joints that occurred, running nearly parallel with the dike, much facilitated the labor of quarrying and were considered beneficial to the quarry. But time and experience have proved that most of the marble obtained at these localities is not valuable in consequence of the numerous hidden joints or "tight cuts" which, upon exposure, appear so abundant as to disfigure the slab, and not unfrequently it parts asunder at these joints.

The occurrence of dikes called "ore veins" or "black streaks" by the quarrymen,—in consequence of their black and semi-metallic appearance,—on Eolus and Danby Mountains is not uncommon, and several occur in quarries at the north end of the mountain near Danby Borough. The removal of marble has exposed several dikes, portions of which are left in the side walls of the quarry, one of which (in Griffith's quarry) presents a very unusual appearance (see Fig. 324.) The injected matter forming the dike appears to have filled the fissures, the sides of which were not parallel, nor were the fissures parallel to each other. One has a dip of 82° E. and the one east of it has a dip of 54° west. At the

FIG. 324.



Trap Dikes on Danby Mountain.

nearest point they were three feet apart. In the Figure the black represents the dike, and the lines show the joints that occur in the marble near them. In this instance—and indeed in all cases that we have witnessed—the joints in the marble are nearly parallel to the sides of the dike. This is clearly shown in the dike represented by Fig. 324, where the dikes are not parallel to each other, but the joints are parallel to the dike. In the side of another quarry (Kelley's) there is a dike four and a half feet thick, having a dip of 75° N.W. Near the top of the exposure of this dike, for the distance of five feet it is made narrower by the occurrence of jointed marble in its stead.

At the time of visiting these quarries, parties were endeavoring to obtain sound marble not far from one of these "black streaks." We expressed doubts of the existence of sound marble there, when one of the workmen unhesitatingly replied, "We shall be sure of sound marble when we get below this *ore vein*." He realized the fact that marble was unsound near dikes; but not understanding their nature—that they were intrusive masses forced up through fissures from great depths, like the lava of a volcano—he imagined that man, aided by gunpowder, would be able to get below them!

But a very large majority of the quarries thus unfavorably situated have been abandoned, and those that are not will be quite sure to involve the proprietors in bankruptcy if the effort to work them for sound marble is persisted in. Many worthy and rather shrewd men have lost money, and not a few have expended fortunes, in the effort to obtain sound marble in situations where internal forces had been exerted to such an extent as to render the marble wholly unfit for use in consequence of the numerous cracks found in it. The labor of removing the superincumbent mass of earth and waste rock, before good marble can be reached even in the best quarries now worked, is attended with a great outlay of capital. But when a reasonable hope, grounded upon good evidence of the existence of sound marble, is entertained, and the explorations are judiciously managed, capitalists need not fear making the investment.

The quarries from whence were obtained the coarse friable marbles, like that from the "cave quarry," on Dorset (Eolus) Mountain, are also mostly abandoned, because the marble was not found durable when exposed to the weather. The porous nature of the rock permitted the rain and moisture to penetrate, and in cold weather the expansive power of ice would throw out the grains upon the surface, and ultimately the exposed edges would crumble and become rough, and on the top of the slab there would be found the comminuted fragments in the form of sand, examples of which may be seen upon tombstones in many of the cemeteries of Vermont and elsewhere. Monuments and slabs are very apt to become disfigured by the growth of lichens and mosses that readily find root and gain sustenance from the moisture contained in the porous rock of which they are made. Hence, if durable monuments are desired, a selection should be made of marble that is compact, close-grained, and perfectly free from joints.

Objections are sometimes made to close-grained marbles that contain silex, because they are hard to work; but a little reflection will convince an intelligent mind that where the cohesive force is so strong and unyielding as to resist the chisel of workmen, the same force will be able to withstand the encroachments of frost and other eroding agencies. But the quarries now worked in Vermont usually produce sound marble, of good quality, that finds a ready market in all parts of the country. A brief examination of the quarries will be made. The variety which has been denominated *Vermont marble* is principally obtained in Bennington and Rutland counties.

On a hill about one and one-half miles southwest of North Shaftsbury is an old marble quarry, formerly worked by Samuel Cranston. It has been abandoned several years. The marble is very fissile and friable, and would not prove durable. It has a strike N. and S., with a dip 10° E. It has a jointed structure which would prevent large blocks from being taken out; and this fact, taken in connection with the fissile nature of the rock, should deter any one from making the attempt to obtain valuable marble from it.

On land of Jacob Huntington, in the south-west portion of the town, is another abandoned quarry; and there is also one in the north part of the town, on land of Mr. Prindle. But in neither of these cases is the marble of a compact structure, or of such a quality as would demand a ready sale, even if it were quarried.

The most southern quarries now worked in the town of Arlington, are in the valley of the Battenkill River. The beds here do not extend very far with a uniform dip, but are quite irregular. Some are nearly horizontal; others are found dipping to every point of the compass, and at various angles. The quarry worked by Messrs. West & Canfield is south-west of the village, and has a strike N.E. and S.W., with a dip of 45° N.W. The marble is generally striped, and is not a pure carbonate of lime, but magnesia and silex

enter into its composition, the latter in such abundance as to prevent its being highly polished. This marble occurs in "sheets," varying in thickness from six inches to three feet. Like the sheets of granite before alluded to, they are found nearly horizontal. Blocks are raised from this quarry and sawed so as to have the stripes—which correspond with the planes of stratification—cross the slabs diagonally, and it presents a unique appearance. The marble is not of a fine quality, but is very good for a building stone, for which it is principally used. Messrs. West & Canfield have a marble mill near the quarry, in which they run four gangs of saws. Another quarry owned by them, but not now worked, is situated about one hundred rods east of the one above described. It has a strike E. and W., with dip 16° S. The upper beds are striped, and the lower ones white. The marble is quite coarse and silicious.

Messrs. O. & A. D. Canfield have a quarry about one-half mile north of the ones last described. The strike is N. and S., with a variable dip, being, in the best portions of the quarry, 20° W. This quarry was worked fifty years ago, and much marble has been taken from it. In it there is a great variety, but very little of it is fine-grained and pure. It is generally very silicious, too much so to receive a good polish; but it is quite durable when exposed to the weather. Many curious phenomena are presented in this quarry. In some portions the strata are wedge-shaped; in others curved; and what is most singular and interesting is the occurrence of *faults*. These are rendered apparent by the stripes that are abundant in the marble, and show that a slide of half an inch to those one foot or more, are not unfrequently made. What is singular, the joints where the fault occurs is rendered perfectly solid by a silicious cement.

Cases are common in marble taken from this quarry for the end of a white stripe to abut against and be firmly cemented to a dark one, with scarcely a trace of cementing matter visible between them. Specimens of this marble, showing the slides alluded to, may be seen in the State Cabinet, which were contributed by the gentlemanly proprietors. A mill with four gangs of saws, owned and worked by the company, is situated near the quarry.

West from the village of Arlington, about one and one half miles, is a quarry known as the McKee quarry. It was opened about forty years ago, but is now abandoned. It is situated at the south end of Red Mountain, in an eroded valley, through which the Battenkill runs. The beds (strata) are nearly horizontal. On the west, the overlying rock has a dip to the west of 15°, and that on the east dips east 40°. The base of Red Mountain is doubtless composed of a coarse quality of marble, upon which repose thick beds of limestone of different degrees of purity, and on the top of the latter there occurs a slate known as a magnesian or talcoid schist.

Equinox Mountain, which is similar in structure to Red Mountain—but considerable higher—has marble in it, but at a greater elevation than that of Red Mountain.

Between Equinox and Mount Eolus, a wide space of comparatively level country intervenes. The outcroppings of rock in this section, and to the west of it for several miles, give evidence that when the rocks were in a yielding and plastic condition, forces then existing rent them asunder, and deposited the fragmentary masses in irregular positions.

Stratified limestone and beds of marble are found dipping towards every point of the compass, and are rarely found to extend in the same direction for a great distance.

Although the strata are often curved, still very few joints are found in the marble, which is evidence that the forces that were exerted to produce these results upon the rocks, took place in a comparatively early stage of the existence, and before the marble had attained that degree of solidity to be injured by those disturbing agencies.

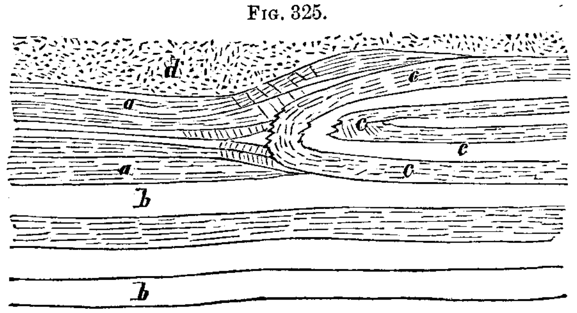
About three miles south of Dorset village, is the quarry owned and worked by Messrs. M. & G. B. Holley. At the time of our visit, fifty men were employed at this quarry, and at the mill for sawing the marble, situated about sixty rods distant. In the mil were eight gangs of saws that annually cut out about 75,000 feet* of marble. The strike of the marble is N. 30° E., and at the west side of the quarry has a dip of 30° E. The marble is well calculated for a building stone, for which it is sawed, and finds a ready sale in Philadelphia. The beds of marble vary in thickness from one to five feet, and have open "riving seams" between them.

About one mile north of the quarry last described, is one owned by Robert P. Bloomer. It has a strike N. 30° E., with a dip of 10° W. The marble at this quarry is usually white and thick-bedded, but not of fine quality. The quarry was not worked at the time of our visit.

Messrs. Way, Wilson, Sanford and Company, work a very valuable quarry nearly west of the one last named. The strata are nearly horizontal, and marble of a good quality is easily obtained.

Eighteen men were employed at the quarry at the time of our visit, and during five months had raised 1804 tons of marble, enough to produce over 100,000 feet of sawed slabs. This quarry was overlaid with about ten feet of compact blue limestone, and about twenty feet of earth, gravel, &c. A very singular phenomenon presents itself at this quarry. The blue limestone overlying the white marble has distinct stratified beds that are perfectly folded together. They appear to have been folded when in a plastic state, but were more solid than the striped marble of this quarry, for it appears as though this folded limestone had by some lateral pressure been forced *into*, and removed the striped beds that overlaid the white marble.—This folded mass appears also to have been arrested in its course at this place, for upon the removal of earth, limestone and marble, the fold is shown in the side of the quarry, as represented by the adjoining cut (Fig. 325.) The strata of striped marble remaining are represented at *a*; the white marble bed at *b*, *b*, the fold of blue limestone at *c*, and the overlying gravel and soil at *d*. The white marble at this quarry has been securely protected from the injurious effects produced by atmospheric agencies, by the overlying limestone and earth, and the striped variety is comparatively sound if obtained eight or ten feet from its junction with the blue limestone.

Fig. 325.



Messrs. Holley, Fields & Kent own and work the next quarry that will be noticed.—It is situated about one and a half miles south-east of Dorset village. They have a mill

* A foot of marble contains 144 inches of surface, and two inches in thickness.

about one and a half miles from this quarry, with six gangs of saws that cut out about 75,000 feet of marble annually. Forty hands are usually employed in and around the quarry, and 150,000 feet of marble was raised in seven months in 1858. The beds — eight in number — are undulating, but nearly horizontal, and the marble is white and sound. The quarry has been perseveringly worked for fifteen years. When first opened, "riving seams" or open fissures between the beds or strata of marble were abundant. The marble has been removed, and the quarrymen are now at work eight or ten rods from the edges of the beds that were first opened, upon beds that run *into* the hill, and the marble now found is very solid, and the "riving seams" are hardly perceptible. When marble is found destitute of joints or "riving seams" as in this quarry, it is necessary to *channel* round the blocks before they are removed. Channeling is done with long drills with chisel-shaped edges. The channel or groove is from one to two inches wide, and long and deep enough to extend the length, width and depth of the block to be raised. This being done, wedges are inserted in accessible points at the bottom of the block, in front or at the sides, and upon driving them into the "riving seam"— or in the absence of these, into holes drilled for the purpose — the block is cleaved from its bed.—With the derrick which is found in nearly all quarries, these blocks may be readily moved and loaded upon cart or car when necessary.

At this quarry it costs twenty-eight cents a foot to get these channels cut. A good workman will cut from five to ten feet — that is a groove one foot deep and from five to ten feet in length—per diem, which yields a daily income to the workman of $1,40 to $2,80. The prices at which the Dorset white marble is sold is about as follows:

2 inch Head Stones, ...	5 cents per foot.
Hearths, 1⅛ inch, 20 cents; Edged, ...	22 " "
" 1½ " 23 " "	25 " "
Posts, 5 inches square, ...	20 cents per foot, length.
" 6 " "	30 " " "
Strips, Window Caps, Sills, and Building Marble generally,	$1,50 per foot cubic.

Several other quarries are in this vicinity, but they were not sufficiently examined to enable us to report upon them.

When passing round the south end of Eolus Mountain, in Manchester, the traveler can see, far up the sides of the mountain, two blotches of white that resemble snow banks. These mark the spots where the *debris* of two marble quarries are deposited. The one on the west — the smaller one — is near the quarry of Messrs. Clark & Folsom, of Manchester. At the time of our visit this quarry was not worked, but the quality of the marble and the facilities for obtaining it are such as should warrant an investment, adequate to carry on the work of quarrying it.

The "Vermont Italian Marble" quarry is located a short distance east of the one last named, and its position is seen on Plate XXXIII, at the light spot shown at the right hand of the mountain, more than half way up to its summit. It is situated 1263 feet above the depot at East Dorset, and about one and a half miles distant, and is reached by a road from that place that winds up along the side of the mountain. It is owned and worked by Messrs. Holley, Fields & Kent, of East Dorset. The marble of this quarry has not the snowy whiteness of that found in the other quarries of Dorset; but it is usually shaded with sprinklings and bands of a light gray, or bluish-white, closely resembling the Italian marble—hence its name. It is not a pure carbonate of lime, but silex enters into its composition in such quantities as to render it hard and durable when exposed to the weather, but is not so abundantly disseminated in it as to prevent its receiving a good polish. It is very compact in structure, and when struck it has a ring like that of metal. Unlike most fine-grained, compact marbles, this is remarkably free from joints or cracks.

The beds of marble in this quarry lie nearly horizontal, and between them there are "riving seams," or open fissures, that allow the removal of blocks without the aid of riving wedges. Holes are now drilled at right angles with the strata, and wedges are inserted that cleave off blocks of the desired shape and size for sawing. But as the beds are penetrated at greater depth, the open fissures between the beds, that were occasioned by the decomposition and disintegration of the shaly beds that intervened, will disappear, and within a few years the company will be obliged to channel around the blocks before they can be raised, but they will be amply compensated for the extra expense, by the improved quality of the marble obtained. The aggregate thickness of the beds or "tiers" that are worked, is forty-six feet, exclusive of the worthless seams of shaly matter that intervene.

The following is the name applied to each bed, and its thickness, beginning at the bottom of the quarry, to wit:

1 Lower birdseye,	16 inches.	8 Thick white,	20 inches.
2 Cast iron tier,	14 "	9 Upper dye,	22 "
3 Shale tier,	20 "	10 Fine white tier,	20 "
4 Lower dye,	4 feet.	11 Upper shale,	5 feet.
5 Striped tier,	3½ "	12 Leopard tier,	5 "
6 Cross grained tier,	3 "	13 Upper birdseye,	4 "
7 Sheet tier,	15 inches.	14 Striped tier,	2 "

The 15th, 16th, 17th, and 18th tiers have, in all, a thickness of nine feet, and afford only a second quality of marble, generally striped.

More than 200,000 feet of marble are annually raised and sold from this quarry. It is mostly sawed at East Dorset in the mill of I. Cochran, Esq., where ten gangs of saws are run by steam. The Company now contemplate erecting a mill of their own to be worked with that of Mr. Cochran—for the latter, although capable of cutting out 200,000 feet annually, is inadequate to supply the amount of marble demanded from the quarry.

The following is a list of prices taken from the card of the Company:

1 Inch No. 1,	25	cents per foot.
1 " " 2,	20	" "
2 "	40	" "
3 "	55	" "
4 "	70	" "
5 "	85	" "
6 "	$1,00	"
Hearths, 1¼ inch,	25	" "
Tile, 1 inch thick, sizes to order,	20	" "
Posts, 5 inches square,	25	cents per foot, length.
" 6 "	33	" " "

Strips, No. 1, $2,00, cubic; No. 2, $1,50, cubic.
Monuments, $2,50 to $3,00, cubic, boxing included.

The deposit of marble in the mountain near this quarry is enormous, and will prove inexhaustible for many years to come, even if the number of hands working it were quadrupled. But the expense of working the quarry must be annually augmented, not only in consequence of the greater compactness of the marble, and the absence of riving seams between the beds, but also from the amount of overlying rock which continually increases, as the work is driven along the beds into the mountain. At present a thickness of thirty feet of limestone overlies the edge of the north wall of the quarry, but upon penetrating the hill ten rods further, the overlying rock will have a thickness of about one hundred feet.

Between the upper beds of marble and the overlying limestone there is a silicious deposit, in which are often found fine quartz crystals. Alonson Gray, Esq., the superintendant of the works at the quarry, presented several fine specimens of these crystals to the State, which are now on exhibition in the Cabinet at Montpelier. In some of the marble of this quarry there is a reddish color found, oftentimes several inches in thickness. This color does not run with the planes of stratification, but crosses them, and is nearly or quite parallel with the "sliding seams" of the quarry. It is not, however, found in connection with *all* of them, but is restricted to those only that have in them a reddish substance, unctuous to the touch, and closely resembling kaolin in appearance.

It is very evident that the color was imparted to the marble from this red substance, and subsequent to the time when it was deposited, but at a period prior to its solidification. From all the surrounding circumstances it is apparent that this red substance is lithomarge or decomposed porphyry. It very closely resembles, and is probably in all respects similar, except in amount, to the material found in the "paint dike" at North Dorset, a description of which is given elsewhere in the chapter upon PAINTS. Hence, it appears that when the marble was in a plastic state, intrusive matter, in the form of a diminutive porphyritic dike, was forced up into the fissures that existed, but not in quantity or with intensity sufficient to shiver the marble near it.

Above this quarry there is a slaty formation of limestone, about 400 feet thick, upon which rests a coarse, friable, white marble, which forty years ago was quarried quite extensively at a place called the cave quarry, it being near a cave which is found on that mountain at an elevation of 1750 feet. This white marble formation has a thickness of about one hundred feet, on top of which rests a blue limestone of about the same thickness. Upon this blue limestone, at an elevation of 1970 feet, a schist occurs, with concretionary masses of quartz in it, and extends to the top of the mountain, which is 2468 feet above East Dorset, and 3148 feet above the ocean.

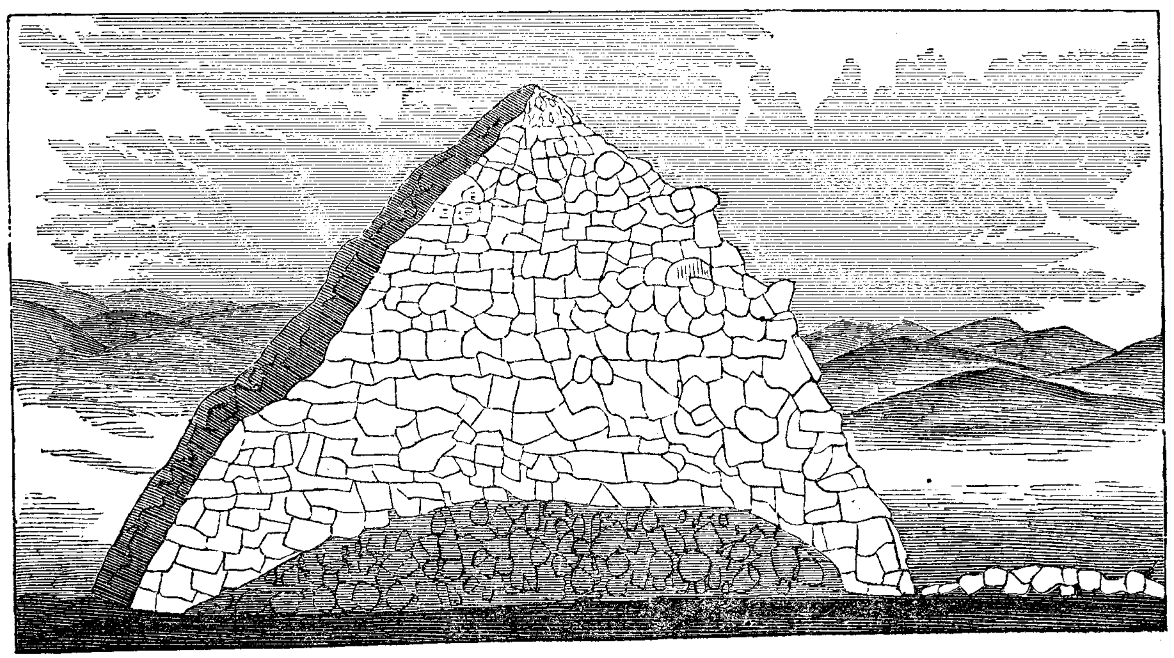
The quarry of Messrs. Friedly & McDonald is seen from East Dorset, about two miles distant, upon Eolus Mountain, at an elevation of over 1200 feet above the village. This quarry has been worked about twelve years, and has furnished a large quantity of marble. Its texture is not as fine as that from the Italian marble quarry that is situated nearly two miles south of it, but is of fair quality, and durable when exposed to the weather. It is not usually as white as that from many other quarries in Dorset, but is lighter-colored than the Italian.

During the past four years there has been quarried about 110,000 feet, or nearly 2000 tons, annually. The beds of marble in this quarry, which are nearly horizontal, were first worked near a dike that is about six feet thick; but the proprietors very wisely worked *from* it into the hill, where there is found good sound marble. The quarry is worked about fifteen rods in length, and marble has been removed six rods from the place first opened. A perpendicular wall of rock, including the marble, stands upon the western side of the quarry, one hundred feet high. A very great expenditure will be required to remove the overlying rock so as to bring the marble within reach. But it occurs to us that a more feasible expedient to reach the marble would be to tunnel into the hill over the beds, in a manner similar to the plan adopted at the West Rutland quarries.

Several abandoned quarries are found in the vicinity of the one last described, among which are the "Old Company's Quarry," the "Mud Hole Quarry," &c.; but the foregoing are all the quarries on or near the south end of Eolus Mountain that were worked at the time of our visit.

In the "Mud Hole Quarry" there is a portion of a basaltic dike remaining, from around which the marble has been removed. It is four feet thick, thirty feet long, and twenty feet high in the highest point. From the concretionary nature of the rock of which it is composed, it resembles the remaining portion of a huge wall. A sketch of this is given below, (Fig. 326.) Forty years ago marble was obtained and sold from this quarry, but during the last ten years it has been abandoned.

Fig. 326.



Dike on Mount Eolus.

On Danby Mountain, a northern continuation of Eolus, there are several quarries, the marble from which is shipped from the depot in Danby Borough. The most eastern quarry is known as the "Old Griffith Quarry." In this the strata are slightly curved, but have a general dip to the south-east of about 10°. At the time of our visit this quarry was not worked.

Thomas Symington's quarry, proceeding westerly, is the next. Sixteen hands were employed at the time of our visit. The marble from this quarry is mostly shipped in the block to Baltimore, Md., the residence of the proprietor. It has been worked about four years, and has furnished some of the whitest marble ever found in Vermont. Six beds are worked, and have a dip of about 16° S.E. The upper bed, which is about four feet thick, is striped, and a fair quality of marble. The second one is a striped slaty bed with considerable quartz and calcite in it, and is worthless.

Next below this is a bed three and one half feet thick, which is nearly white, but the marble is rather too soft to prove durable. It is called "No. 2 layer." "No. 3 layer" is four feet thick, and except a narrow belt at the bottom is very white, and furnishes the best marble found in the quarry. The next bed, "No. 4 layer," is variable in thickness and quality. In some places it is thirty inches thick and of a poor quality, while in other places it is not more than fifteen inches, and in some portions of it the quality of the marble is good. The prevailing color is white, with bluish-gray spots in it. Between this bed and the one below it, there is a stratum one foot thick composed of quartz, calcite, slate, &c., and is worthless. "No. 5 layer" is from three to four feet thick, and furnishes white marble of good quality. The bottom bed, "No. 6 layer," has a thickness of three feet, and is a compact white marble, with a light gray stripe passing through the bottom of it.

By the foregoing, it will be seen that the quality and color of marble varies in the same quarry, and worthless beds occur in the midst of valuable marble. The beds above enumerated, extend through the quarries on the north end of the mountain, and are readily recognized by the workmen. But they do not always possess the same uniform characteristics. For example, the bed denominated No. 3, in the Symington quarry, is usually white, but has a very different character in the Griffith quarry, which is about 25 rods distant. In the latter it is a clouded marble thickly mottled with gray, and is called the "calico layer." The beds of the Griffith quarry are thicker than those in Symington's, and it is a noticeable fact that upon this mountain the beds invariably thin out as they extend west.

The next quarry to the west is owned and worked by W. W. Kelley, Esq. In consequence of the numerous joints and "sliding seams" in this quarry, we were not very favorably impressed with it, although it contains some good marble. The beds in this quarry have a greater dip than in the last described, being inclined about 30° from the horizon.

In the western part of the same quarry there is a wedge-shaped dike, which, at the top, is not more than one inch thick, but at the lowest point shown in the quarry, by the removal of marble, is six inches; and one hundred feet below, in the road leading up to the quarry, it is one foot in thickness. It has a strike N. 35° E., and dips 70° N.W. Another large dike forms the western boundary of the quarry, and has a dip and strike nearly corresponding with those just described. Adjacent to these the marble is worthless, in consequence of the numerous joints found in it.

This quarry is interesting from the fact that a *fault* occurs at the east end of it, where the "layers" or beds of marble abut against the dike on the east, six or seven feet higher than the corresponding beds on the west of it. Faults are quite common on this part of the mountain, and beds are rarely found coincident with each other at the "sliding seams," or exactly corresponding on the opposite sides of the dikes. In the "Fish Quarry" a fault occurs where there has been a slide of twenty feet, and at the western end of the quarry a sliding seam is found, tinged with a reddish substance, very closely resembling that found in Curtis' paint dike, at North Dorset. The face of the marble on either side of this sliding seam is striated and polished as though by attrition caused by the subsidence and elevation of the contiguous beds or strata of rock.

Calcareous alabaster, some specimens of which closely resemble the oriental alabaster, is found in the *debris* of Kelley's quarry, in the western portion of it, in the form of concretionary masses, varying in thickness from a few inches to those three feet in diameter. Their form is stalactical and stalagmitic, and occasionally it is found of a cavernous structure. Specimens might be obtained here for ornamental purposes; and were it not for the cavities that occur in many specimens of it, slabs could be obtained large enough for light-stand tops. The concentric zones of honey-yellow, that alternate with those of lighter and browner shades, and the semi-transparency of the whole, render it a very beautiful mineral; and, in the hands of the sculptor or manufacturer of ornamental toys, would be deemed valuable.

Other marble quarries are found in this vicinity, but they possess the general characteristics of those last described. In Danby Borough there are six mills for sawing marble, in which there are twenty-six gangs of saws.

For a considerable distance north of Mount Eolus the rocks give evidence of having been subjected to great disturbance, and, like those south of it, are very irregular in their dip and strike. The fragmentary masses that were severed from the marble beds of the mountain are not as abundant or extensive on the north as they are south of the mountain. To the north and west of the mountain, for several miles, the rock *in situ* is principally talcoid schist.

In the valleys of Tinmouth River and Otter Creek extensive beds of marble exist, and in several places quarries have been opened. The most southern quarry in the Tinmouth River valley is in the south part of Tinmouth, on land of David Edmunds. The beds of marble in this quarry—now abandoned—are very much curved, and appear as though they had been subjected to lateral pressure, and broken off from other portions of the beds that extended further south, but at a time when the material was in a yielding or plastic state, and capable of being bent. The strike and dip in this quarry are variable. In the northern portion of it the beds dip west 20°, but in the southern portion they dip 30° S.W., and in some places nearly south. The marble of this quarry is quite coarse and friable, and probably would not remain long uninjured if exposed to the weather.

On land of Abner Colvin, in Clarendon, south-west from the springs, there is an abandoned marble quarry. The strike of the rock is N. 30° E., and dip 16° W. The quarry rests on a magnesian limestone. Some of the marble is white, but the stratification planes are so abundant that it is questionable whether the marble would be valuable if quarried.

About one half mile north of Clarendon Springs there is a quarry from which considerable marble has been taken. The strata here strike N. 10° E., and dip 42° W. This is the most northern outcrop of marble found in this valley that dips to the west. On the

opposite side of the valley, about three-fourths of a mile distant, beds of marble dip to the east at an angle of about 20°, and were doubtless once united and continuous with those on the west side of the valley.

From the south line of Tinmouth to a point about two miles north of Clarendon Springs an anticlinal axis extends, on or near the line of which Tinmouth River runs. In Tinmouth the dip of the rock is much greater than in Clarendon, and in the south part of the former town the quartz rock—the base of the series in which the Vermont marble is found—has a dip of 75° to 85°, and the marble, which has a position about 1000 feet above the quartz rock, is found far up the hill to the west. On a line with Tinmouth village, the average dip of the rock is about 45° W., and that on the east side of the anticlinal line 55° E., the uplift being sufficient to bring to view the upper beds of the quartz rock. From this point to Clarendon Springs the dip slowly diminishes, and the quartz rock and silicious limestones gradually disappear. A magnesian limestone, that occurs but a short distance below the marble beds, is the rock in place at the Springs,—it is through a fracture in this that the spring water exudes. The rocks upon the east have a dip of 20° E., while those upon the west of the line of fracture dip to the west from 10° to 15°.

The Otter Creek valley runs nearly parallel to that of Furnace Brook (or Tinmouth River), and like it has upon the western side extensive beds of marble. These beds are brought to the surface by undulations or folds in the strata; and in many places, by extensive erosions, large portions of the marble beds have been removed, and the remaining portions show their edges in the hill-side.

The most southern quarry worked in this valley is at South Wallingford, and owned by J. Adair and brother. The dip is variable in the quarry; the beds in the eastern part having a dip 72° W., while those further west dip only 40° W. The strike is N. 40° E. At the time of our visit (in 1857) the proprietors were filling a government order in furnishing marble for a Custom House to be erected at Charleston, S. C. About seventy-five men were employed in quarrying and finishing the blocks ready to be placed in the building. The marble has not the fineness of that found at West Rutland and in the more northern quarries, but it is of fair quality.

In this quarry there is a large pot-hole twenty feet in diameter, of circular form and very smooth upon the sides. Marble has been removed from one side of it to the depth of about ten feet, and although filled with mud, it has been penetrated to the depth of fifteen feet with an iron bar, making in all a depth of at least twenty-five feet.

About one half mile north of this, there is a quarry owned by Anson Warner, where an opening has been made and some white marble been obtained. The strata in some parts of the quarry are much contorted, having a variable dip of 65° to 85° W. The quarry is situated so low that it is difficult to keep it drained, but aside from this the quarry seems to be a valuable one.

Gen. Robinson Hall has a quarry one mile north of South Wallingford, in which five workmen were employed at the time of our visit. The beds have a strike N. 15° E. and a dip of 50° W. The quarry has not been penetrated to great depth, but marble of very good quality has been obtained from it, and the quality of the same will continue to improve as the beds are penetrated. Upon the hill-side at the height of one-hundred and twenty feet above this quarry, there is a bed of brecciated limestone of considerable thickness, and apparently sound and free from joints; and it is not improbable that if the surface rock were removed, ornamental marble would be found valuable.

Further north towards Wallingford village, outcrops of marble beds are met with nearly the entire distance, but no other quarries are yet worked. The Otter Creek, in Wallingford, runs nearly on a line with the fracture corresponding with the anticlinal axis; and the rocks in place are found to dip into and under the hills on either side of it. In the vicinity and north of Wallingford village, the strata are not continuous for a great distance, but the rocks are found to dip toward every point of compass. The beds of marble thin out in this vicinity, and they are adulterated with silica, alumina, and magnesia, and the prospect of finding good workable beds is not very flattering.

On a line north of the beds at Clarendon Springs, are found the celebrated quarries of West Rutland, that are near the line of, and connected by a track with the Rutland and Washington R. R. Through the persevering efforts of the proprietors, the Rutland marble has found its way to every State in the Union, and the valuable varieties challenge the admiration of all who behold them.

Like all marble quarries, those at West Rutland produce *some* poor marble, but if a dealer desires good marble from any of them, he can and will get it, if he orders and pays for a good article, for the marble dealers of West Rutland are proverbial for their integrity and fair dealing. The most southern quarry in the group north of the village, is owned and worked by Messrs. Sheldons and Slason, a view of which is given in Plate XXXVI. The strike of the beds is N. 10° E., and the average dip is 45° E. Excavations have been made, and marble raised, to the depth of 133 feet. More than 200 men are employed by this company, in raising and preparing the marble for market. A large steam mill owned by the company (seen in the sketch) is situated near the quarry, and in it are nineteen gangs of saws and two whip-saws. It is estimated that this company quarry 500,000 feet of marble per annum, most of which is sawed and sold by them in the slab. The marble is mostly white, but like all other quarries the beds vary in color and quality. Occasionally there is found a difference of color in the same bed. In one of them (the sixth) the marble at the outcrop was gray, but at the depth of 90 feet it became changed to a beautiful white. Twelve beds or layers are worked at this quarry, having an aggregate thickness of forty-seven feet, each of which has distinguishing characteristics that are readily recognized by the practiced eye of the proprietors.

Beginning at the eastern side, or top layer, they are named and have each a thickness as follows:

1	Upper blue layer,	4 feet thick.
2	Upper white layer,	3 feet 6 inches thick.
3	Gray limestone layer,	5 feet thick.
4	White statuary layer,	3 feet thick.
5	Striped layer,	1 foot 8 inches thick.
6	New white layer (gray at top),	4 feet thick.
7	Wedged white layer,	from 8 inches to 2 feet 6 inches thick.
8	Muddy layer,	4 feet thick.
9	Striped green layer,	4 feet thick.
10	Camphor gum layer (much calcite in it),	3 feet thick.
11	White layer,	9 feet thick.
12	Blue layer,	3 feet 6 inches thick.

Specimens of marble from this quarry are to be seen in the State Cabinet.* The beds at this quarry, and all others at West Rutland are so compact, that the marble is obtained by channeling round the blocks before they are raised. It is an interesting scene to behold two hundred quarrymen ranged in rows, in those deep quarries, each with his long sharp drill, steadily cutting deeper and longer those grooves that are destined to sunder the fetters that bind those valuable blocks to their parent bed. The musical ring of the quarrymen's drill, that reverberates to the ear from the deep vaulted quarry, is pleasing to the spectator, as he stands upon the brink and looks down into it; and to the proprietor it is the welcome harbinger of "the good time coming," for a successfully wrought quarry is quite sure to bring fortunes to the proprietors.

Messrs. Adams & Allen, of Fairhaven, Vt., own and work the next quarry north of the one last described. The strike of the beds is nearly north and south, and they dip east 55°. There are employed by this company about 100 men—75 at their quarry and 25 at their mill in Fairhaven. In their mill there are twelve gangs of saws, that cut out about 200,000 feet of marble annually.

The marble obtained from this quarry and the one immediately connected with it on the north is excelled in quality by none in West Rutland, as may be seen by the beautiful cubical blocks furnished for the State Cabinet by Messrs. Adams & Allen.

Immediately north of this, and upon the same beds, the "Rutland Marble Co." have raised a large quantity of excellent marble from their spacious and valuable quarry.—The dip of the layers at the north end of the quarry is 34° E., and at the south end at the points of junction with the Adams & Allen quarry the dip is 44° E. About 125 men are employed in channeling and raising the marble from the quarry. The company have no mill of their own for sawing marble, but sell it in the block. Most of it is sold to Messrs. W. Y. Ripley & Son and to Messrs. Clement & Gilmore, both of which firms have excellent mills for sawing marble at Center Rutland. In the mill of Messrs. Ripley & Son there are fourteen gangs of saws that cut out 160,000 feet annually of marble, and in that of Messrs. Clement & Gilmore there are twelve gangs of saws from which are produced 150,000 feet of sawed marble annually.

The quarries of Messrs. Adams & Allen and the "Rutland Marble Company" are not upon the same beds as the one of Messrs. Sheldons & Slason before described, but upon beds further west, there being a stratum of about fifty feet in thickness of limestone between the two series of marble beds. The West Rutland quarries, and their relative position, is given in a plan upon the Geological Map, Plate I. There are ten beds of marble worked in the western division, and have an aggregate thickness of about thirty-

*The following extract from a Circular of the Company will give prices of marble, delivered on board the cars at West Rutland:

"Our prices are as follows:

Slabs.		*Monument Stuff.*	
Statuary,	$0,84 per square foot 2 in.	Statuary,	$5,40 per cubic foot.
No. 1	62 " " "	No. 1,	3,60 "
" 2	42 " " "	" 2,	2,40 "
" 3	25 " " "	" 3,	1,50 "
Common blue,	25 " " "	Common blue,	1,50 "
Italian blue,	50 " " "	Italian blue,	3,00 "

An additional charge of twenty-five cents per cubic foot for boxing monument stuff.

SHELDONS & SLASON,
SUCCESSORS OF
SHELDONS, MORGAN & SLASON."

five feet. Commencing with the upper beds the following is the order and thickness of the layers:

1 White layer,	2 ft. 6 in. thick.
2 Striped layer,	2 " 4 " "
3 Nine-foot layer (consisting of a bluish, variegated marble, in the upper portion of the layer, about three feet thick, the remainder being a water-colored marble, with bluish specks in it),	9 ft. thick.
4 White statuary layer,	4 " "
5 White layer,	2 " "
6 Slaty magnesian limestone,	1 " 8 in. thick.
7 Compact striped layer,	2 " "
8 Brocatella striped (a mottled variety),	3 " "
9 Green and white layer (the upper portion white, the lower a mottled-green, very fine for building stone),	3 ft. thick.
10 Six-foot layer (a white, compact marble, with green spots, much used for monumental purposes),	6 ft. thick.

The blocks for the statue of Ethan Allen now in the Capitol at Montpelier were obtained from this quarry, and weighed about fourteen tons.

The "Rutland Marble Co." have opened but a small portion of the marble ledge which they own. It was upon what is now their land, near the northern line, and upon the eastern beds, that J. R. Barnes, Esq. first commenced quarrying for marble in this place; and the spot is now generally known as the "Barnes quarry," while the southern one is usually called the Baxter quarry from the fact that Gen'l H. H. Baxter is the principal proprietor.

Messrs. Sherman, Holley & Adams, of Castleton, own and work the quarries next north of those belonging to the "Rutland Marble Co." They have worked upon both series of beds. The dip of the marble in these quarries, and in the "Barnes quarry" which joins the eastern beds upon the south, is less than in any other quarry belonging to these beds, being only about 25° E. The marble obtained from these quarries is of excellent quality, and is shipped by railroad in the block to the mills of the company in Castleton and Fairhaven,—the former of which has in it six gangs of saws and the latter ten gangs,—from both of which are produced about 200,000 feet of sawed marble annually. They give employment to about seventy hands.

Messrs. Sheldons & Slason have a quarry next north, and on a line with the western quarry of Messrs. Sherman, Holley & Adams. The beds are somewhat curved and have a strike N. 10° W. with a dip from 50° to 65° East. The company work this in connection with their quarries near their mill, and the statistics of marble raised and men employed in this quarry were embraced in the figures given in the report of those.

The "Vermont Marble Co." own and work the quarry next north of the last named, and upon the same beds. This is the most northern quarry worked in West Rutland.—The strike of the beds is N. 15°W. with a dip from 70° to 85° E. About thirty men were employed at the time of our visit, a portion of whom were employed in blasting out refuse marble and opening the quarry. Since the quarry was opened, a stone mill driven by steam, with six (?) gangs of saws, has been erected upon the premises. Considerable marble has been raised and prepared for market by this company, but no estimate of the amount has been furnished us.

A short distance south of the village of West Rutland there are two quarries, one of which is temporarily abandoned and the other is worked by the "Hydeville Co." The dip of the most eastern is 45° E. and that of the one west of it (not worked) is 25° E.—About thirty men are employed at the quarry. The marble is taken by railroad to Hydeville (8½ miles distant) and sawed in a mill belonging to the company at the outlet of Lake Bombazine (46 feet fall in one half mile), in which there are eight gangs of saws that produce about 150,000 feet of sawed marble per annum.

The next quarry to be noticed is located at Sutherland Falls near the north line of Rutland, and within a few rods of the Rutland and Burlington Railroad. At this place there are two quarries—one abandoned and the other worked by the "Sutherland Falls Marble Co." At the time of our first visit we were unable to determine the dip and strike of the beds, for the stratification planes are wholly obliterated, and in the quarry there are no "riving seams," the marble being cleaved with nearly the same facility in all directions. But at a subsequent visit, in a rainy day, the beating storm had wet the sides of the quarry so that the color of the shaded bands on the exposed ends of the strata enabled us to determine the dip and strike of the marble. We ascertained the strike to be nearly north and south with a variable dip from an anticlinal axis both east and west at an angle of from 20° to 60°.

What is very singular and uncommon, the marble in this quarry is perfectly sound and free from joints where the plication occurs. Aside from the one great fold which is near the center of the quarry, the strata are crinkled as though a powerful lateral pressure had been exerted upon them when they were in a soft plastic state. The beautiful appearance of this marble is owing to the existence of the sinuosities in the strata, which have different shades of color; and when sawed, they are brought out and present a mottled appearance upon the plane surface.

The marble obtained from this quarry is not a pure carbonate of lime, but silica enters so largely into its composition as to render it remarkably durable when placed in exposed situations, but not in such profusion as to prevent it from receiving an excellent polish. It is very compact and fine-grained, and in all respects more closely resembles the "Vermont Italian" of Dorset than any other marble in Vermont. But the facility with which it can be cleaved in all directions, and the absence of "riving seams," renders it unlike any other marble in the State. The company employed thirty-three men at the quarry, at the time of our visit, and sawed the blocks in a mill near the quarry on the bank of Otter Creek. In this mill there were four gangs of saws, which cut out about 75,000 feet of marble per annum. But since our visit, the company being unable to supply the demand for their marble, have increased their force at the quarry, and erected another mill, larger and better than the old one, both of which now (Aug. 1860) are in successful operation. Beautiful specimens of this marble are in the State Cabinet, which were presented by the proprietors; and the large monument erected in Hubbardton to commemorate the battle fought there in 1777, was from this quarry.

A large amount of money has been wasted in the hope of finding sound marble at an abandoned quarry, a few rods south of the one now worked. Small specimens of marble of good quality were obtained, but in consequence of the numerous joints occurring in it—probably occasioned by a dike in the vicinity, traces of which may be seen—the strata are too much shattered to be of value for marble. A more feasible point than this for opening a quarry is found upon the land of A. C. Powers, Esq., a few rods north in the town of Pittsford. Several outcrops of good marble occur in Pittsford, but no quarries are now worked in that town.

Brandon furnishes among her numerous mineral products, some of the finest marble found in the State. The only quarry now worked is owned by E. D. Selden, Esq., and situated three miles south-west of the village, near the west line of the town. An excavation has been made, and marble been removed, to the depth of about one hundred and forty feet from the opening. From an analysis of this marble, made by Prof. D. Olmsted, it was found to contain:

Carbonate of lime,	99.55
Silica and other insoluble matter,	.29
Water and loss,	.20
	100.04

A large proportion of the marble of this quarry is of a beautiful white, and is excelled in purity of color and composition, and in fineness and compactness of texture, by no marble in Vermont, and it readily sells at a high price. These facts will furnish an answer to the question why those shallow beds, having an aggregate thickness of only seven or eight feet, can be worked to a profit. The upper bed has a watery, or bluish-white color, and a thickness of about three feet. The lower bed, which has about the same thickness, is of a snowy-white, and in thin slabs or upon the edges it is quite translucent. About thirty men are employed at the quarry, and from six to ten at the mill, which is one mile east of the village, on the road to the iron ore beds. Beautiful cubical blocks of this marble were furnished for the State Cabinet, at Montpelier, and in one of the elegantly finished churches of Brandon there is a desk for the preacher made from this marble, wrought in excellent taste, and highly polished, which was a munificent donation from Mr. Selden, the proprietor of this quarry. About 50,000 feet of marble are sawed annually at the mill and sold, and about the same quantity is sold in the block.

About one mile south-west of Brandon village, and a short distance south of the famous *frozen well*, there is a quarry, owned by C. P. Austin, Esq., which at present is not worked, but which contains in it some fine-grained and valuable marble. The strike of the bed is nearly north and south, with a dip 50° E. A specimen presented by Mr. Austin, is in the State Cabinet.

Near the town line between Leicester and Whiting, and not far from the depot of the R. & B. R. R., are located the quarries from whence is obtained the stone used in the manufacture of the celebrated Whiting lime. The stone used is a remarkably pure carbonate of lime. But associated with this, there are found interstratified beds of impure limestone or marble, which, if wrought, would produce one of the most beautiful ornamental marbles found in the State. It is fine-grained and compact, and of a rich dove-color; and through it run at irregular intervals, beautifully tinted veins of a lively pink color. It receives an excellent polish, and the strata, even at the surface, appear remarkably sound and free from joints; and there is little doubt, if the beds were penetrated to a depth where the rock was not affected by atmospheric agencies, that sound blocks of large size could readily be obtained. The attempt to work the quarry for

marble has never been made. A small, but very beautiful specimen of this marble was presented by J. E. Higgins, Esq., of Brandon, which is now to be seen in the State Cabinet.

In Sudbury there have been several attempts made to quarry marble, but in every case that we have seen, the openings were at or near to a dislocation of the strata,—hence sound marble has not been found, and the result has not proved profitable to those who made investments to carry on the work. The texture and color of the marble are unobjectionable, but, as was said by another, the marble produced "is remarkable for the regular jointed structure and joint-like divisions of the thin beds of marble, which, to a considerable extent, supercede the necessity of sawing."*

The time was when jointed marble was considered worth something, and if the expense of sawing could be obviated by the aid of a jointed structure of the beds, so that slabs could be obtained of the required size and thickness, it was regarded a favorable occurrence; but time has proved the impracticability of using other marble than that obtained from solid beds.

In Middlebury there are several outcrops of marble, and abandoned quarries are now found in that town that were worked fifty years ago. The marble found in Middlebury has a variety of colors—white, gray, drab, cream-colored, reddish and greenish. It is usually fine-grained, and compact in structure, and small specimens of excellent quality, and many of them of a snowy whiteness, can be obtained. But in consequence of the thinness of the beds, its jointed structure, and the interstratification of a magnesian slate that produces numerous "riving seams," it is quite difficult to obtain large blocks that are sound. Although much marble has been quarried and sold in Middlebury, yet we think there is not a quarry in town that has been sufficiently explored to produce perfectly sound marble, or enable any one to judge correctly of its real value. If the beds of many of these abandoned quarries were penetrated to depths beyond the influence of atmospheric agencies, it is highly probable that sound and valuable marble might, in some of them, be found. These remarks apply to those beds that have an inclination of 30° or more into the earth. But attempts have been made, in that town and elsewhere, to obtain marble from beds that were nearly horizontal, and where the land was comparatively level. Now it seems quite reasonable to suppose that all such efforts will go unrewarded, for the hope of obtaining good workable Vermont marble, at or within fifteen feet of the surface, is illusory, as dearly bought experience has too often proved.

In Shelburne several attempts have been made to open quarries, but none are worked at present. One of the most promising beds is situated east of Shelburne Pond, and was worked awhile by Messrs. Tasker, Taylor & Co. Owing to an unfortunate misunderstanding that exists between the proprietors, the work at the quarry is now temporarily suspended. The outcrop of marble at this spot, is of a pure white. The texture is remarkably fine and compact, and upon the edges it has a translucency equal or superior to any other marble in Vermont. The dip of the beds, that occur between thick and unbroken walls of compact limestone, is 78° E., with a strike N. 5° E. Like the Brandon quarry, this has a water-colored or bluish-white stratum overlying the pure white.—The thickness of these beds is about double that of Selden's quarry at Brandon.

*See Prof. C. B. Adams' Second Annual Report to the Legislature of Vermont, p. 233.

Swanton several years ago, furnished a light dove-colored marble of a very fine texture. The quarries are not worked much at present for marble, but the rock is burned for quicklime,—for this it is admirably suited, being a compact carbonate of lime of great purity. The numerous "tight cuts" or close joints that occur in it, seriously injure the marble; and other joints being quite numerous, it is found very difficult to obtain sound blocks of large size.

The foregoing embraces a brief account of the principal quarries of Vermont (Eolian) marble in the State. The statistics given were generally obtained from the proprietor or agent employed at the works, and may not correspond with the facts at the time this Report makes its appearance. In some cases, the number of men employed at the quarries may have been increased since we obtained the data upon which the foregoing is predicated; and in other cases the amount of marble raised, and men employed, may be less than that given; but we have endeavored to report as correctly as possible.

Fortunes have been acquired in many cases, and in others much money has been lost, in working marble quarries. While the proprietors of *good* ones are amply compensated for their investment, there are those who have expended thousands of dollars in opening others that were completely worthless; and it may not be amiss to give some practical hints, that are presented in nature, to guide men in opening quarries.

In selecting a marble quarry care should be taken to secure one where there is a sufficient quantity of *sound* marble, so situated as to be accessible and easily drained if possible.

In order to form an opinion of the *soundness* of the marble, the adjacent rocks should be examined, and if they give evidence that there has been such disturbance among them as to cause a shattered structure, the chances are against a good workable quarry; but where the marble strata are well walled in with sound rock, there is quite sure to be a corresponding soundness of the marble.

Good marble, of the softer varieties, is rarely found within twenty feet of the surface, hence the *dip* of the strata should be so great as to carry the beds *into* the ground beyond the influence of atmospheric agencies, unless the opening be made in the side of a hill, where the strata may be horizontal, as they will be protected by the overlying rock and soil that form the elevation.

Several attempts have been made in Vermont to open quarries where there was a slight dip—not enough to take the bed deep into the earth—but in every case the effort has been attended with failure. A stratum of fine white marble may be found at the surface of the ground, lying horizontal, but it will be unsound in consequence of its exposure, and if it is removed by blasting, or otherwise, the stratum next below it may be marble of an inferior quality, or it *may* be a silicious limestone, or something else. Unless the edges of the strata can be seen, there is no certainty in quarrying, and he who expends much money in blasting out rock that lies in horizontal beds, on level land, expecting to find marble, will be quite sure to make an investment for which he will get no equivalent.

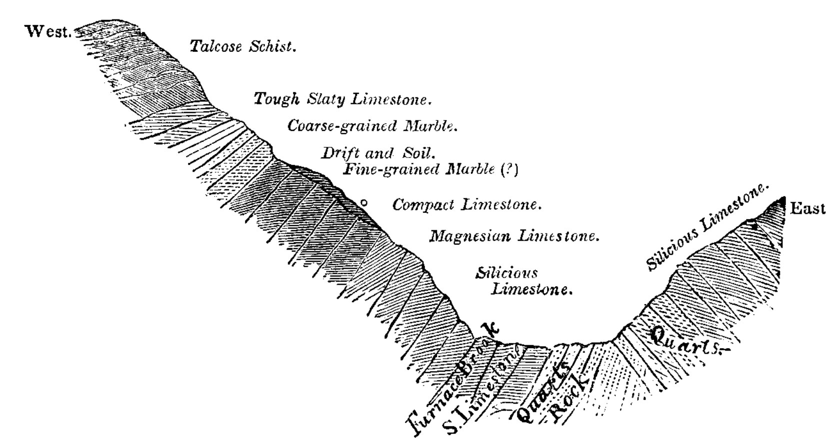
But should there be a horizontal outcrop of white marble, it might, if properly investigated, lead to the discovery of beds that were valuable in the vicinity. It is a rare occurrence in Vermont to find horizontal strata of marble covering large areas; but there are folds and flexures that incline the strata, causing them to disappear beneath the

surface, leaving the edges only presented to view. It is at such points (usually east or west of the horizontal outcrop) that workable beds of marble may exist.

It is but reasonable to suppose that better beds of marble now exist in Vermont, covered with soil, and perhaps beneath cultivated fields, than any that are, or have been, worked. For to any one familiar with the rock structure of the State, it is apparent that the outcrops of limestone are almost invariably those containing impurities or a great amount of silex, or those at a point near which there is a fracture or a fold, that causes the uplifting of the strata. It must be evident that should marble beds occur encased in unbroken strata of limestone that extended for miles in length, there would be a greater probability of finding sound, unshattered marble, than if obtained at a point where there had been a bending or general breaking up of the strata, and the fragmentary masses promiscuously thrown together, and subjected to the powerful lateral pressure that has everywhere been exerted upon the rocks of Vermont.

To illustrate the foregoing proposition, a case will be cited that occurs in Tinmouth. Near the south line of that town there is a quarry before alluded to (David Edmunds'), where there has evidently been great force exerted to bend and sever the rocks in and near it. Indeed, the phenomena there presented are such as to establish the fact almost beyond a doubt, that while the material now forming the marble and associate rocks of that vicinity were in a yielding state, the strata north of the quarry named, and those of Danby Mountain, were continuous; but by some convulsion, or in obedience to some law in nature (either paroxysmal or gradual in its effects), they were severed in twain, leaving those beds forming Eolus and Danby mountains nearly horizontal, while those north, being subjected to a lateral pressure, were uplifted, as shown in Fig. 327, which exhibits a section of the rocks across the valley near the center of the town of Tinmouth.

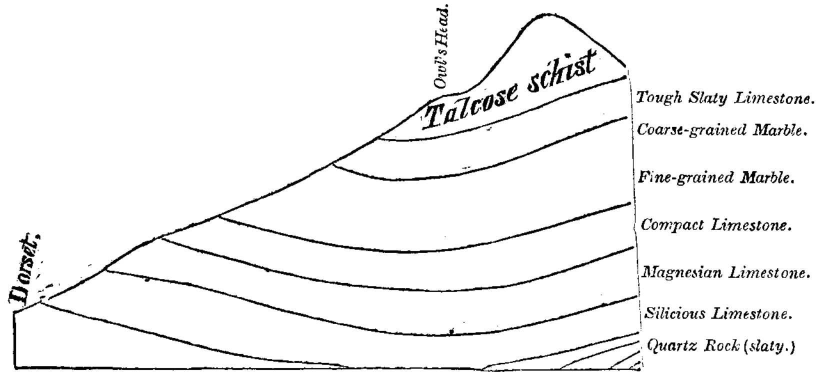
Fig. 327.



Section across Furnace Brook Valley, half a mile south of Tinmouth Center, and ten miles north of Eolus Mountain.

By comparing this with Fig. 328, a section of Eolus Mountain, it will be seen that the same sequence of rocks exist in the horizontal beds of the mountain that are exhibited by the upturned edges of the rock in the valley; and the conclusion is irresistible that the latter were once horizontal, and formed continuous beds with the former, and that since their upheaval time has crumbled their shattered edges, and the eroding agency of water has been called in to complete the work of wearing away the rocks to form this fertile valley.

Fig. 328.



Section on the south side of Mt. Eolus.

Assuming this to be the true condition of things, the prospect of finding sound marble in the undisturbed beds of Danby or Eolus mountains, or in the continuous beds of marble that are held by the unbroken walls of limestone in the upturned strata that extend the entire length of the town of Tinmouth, is far more flattering than at points near where the strata are broken off, or flexures occur in them, revealing an outcrop like that found at the Edmund's quarry. The marble beds existing in Tinmouth, except the outcrop named, are covered with soil; and at the time of our visit, when we measured the Section (Fig. 327), we were unable to discover any outcrop of marble north of the quarry alluded to, but finding a regular sequence of rocks, corresponding with those above and below the marble at the quarry, and similar to those on the mountains south, we concluded that marble beds did exist there, and gave such as our opinion—but that they were covered by drift. Dr. G. M. Noble, of Tinmouth, having had his attention called to our conclusions, made examinations, at a place where a small brook had cut its channel down, to the rock upon the hill-side, and found—in the place where we had suggested that it would occur—a bed of white marble, and from it cleaved off a nice specimen, which is now upon exhibition in the State Cabinet.

There are many places in Vermont, where marble outcrops occur that are not valuable in themselves, but will probably lead to the discovery of valuable beds of marble that lie not very far from them, but now are hid beneath the soil. The dip and strike of the overlying and associate rocks should be carefully observed, for by their aid the hidden beds may be traced out and their situation determined.

From what has already been said it will be seen that Vermont marble is not restricted to one locality, but extends over a large portion of western Vermont. The rock formation in which it is found, extends the entire length of the State. It occurs in beds interstratified with silicious and magnesian limestone. The latter presents a yellowish-brown color upon the weathered surface, and the upper beds gradually pass into a slaty rock formerly known as magnesian slate, but now called talcoid schist. Thin seams of this slate—some not thicker than paper, others an inch or more in thickness—are found interstratified with the magnesian limestone and beds of marble. At these seams, called by quarrymen "floor beds," "bed seams" or "riving seams," the strata are readily parted, by inserting wedges,

after channels are cut around the block to be removed. The channeling is done with drills, made for that purpose, and from two to ten square feet per day is a day's work for a quarryman, the amount varying with the hardness of the marble, and the skill of the workman. In some quarries, the riving seams are a stratum of very fissile slate, an inch or more in thickness, and often so much disintegrated that an open space occurs between the beds, in which case channeling is unnecessary, as large blocks can easily be split off by drilling holes and using riving wedges. As a general thing, the riving seams are open at the surface, but upon penetrating the quarry they grow closer, and often nearly disappear, rendering the labor of removing large blocks more difficult and expensive; but the proprietors are amply remunerated, in finding the marble correspondingly more compact and of better quality, as the quarry is penetrated.

The strata of marble vary in thickness from a few inches to six or eight feet,—the thickest beds being usually found where the marble is coarse-grained and friable. From observations made, it is quite apparent that the marble beds thin out as they approach the north from Dorset, where the thickest beds in the State are found. In tracing the beds to the north, it is also found that the marble is finer-grained and more compact than at the points farther south on the same beds.

From the statistics obtained at twenty quarries, where there were employed 989 men in quarrying, it appears that there were quarried, last year (1857), 3,063,240 feet of Vermont marble, which, if sawed into slabs, would cover more than seventy acres with marble two inches thick.

There are in the State 27 mills, with 176 gangs of saws, where there are annually sawed 1,788,000 feet of marble, or enough to cover 41 acres with sawed marble. At these mills there are employed 312 men, which, added to the number engaged in quarrying, shows that more than 1300 men were employed last year, in this leading enterprise in our State.

WINOOSKI MARBLE.

The next marble to be noticed is found in the north-western portion of the State, and has been worked only to a limited extent. The first quarries opened were in Colchester, near Mallett's Bay, by Hon. David Read, of Winooski Falls. The unsurpassed beauty of the finished slabs greatly pleased him, and when the question arose what name should be applied to it, he very appropriately selected the musical name that is applied to the beautiful river that glides along near his dwelling, and helps to make up the beautiful scenery for which that portion of the State is so justly celebrated. This marble is variable in structure, color and composition. Some varieties are found in laminated beds, that are easily separated, while other varieties are destitute of any evidence of stratification, but occur in solid masses, and split with difficulty in any direction. The prevailing color is red. It occurs in mottled blotches of every conceivable shape and shade in the same specimen, and in some cases a shaded green forms the ground color, through which run various shaded tints of a bright-pink or reddish-brown. These varieties are consequent upon the composition of the rock, which is evidently different in localities remote from each other, and in some cases there is a perceptible difference in contiguous beds.

In some beds, as those at Willard's quarry, near Burlington, silica and alumina enter into the composition in such quantity as to render it unfit for marble, but valuable for a building stone. Further south, upon this formation, silex is the principal constituent of the rock, and, in consequence of the color imparted by the oxyd of iron, it has received the name of red sandstone. It helps to form the summit of Snake Mountain, in Addison, and other peaks of the same type in Charlotte, Ferrisburgh, &c. In many places in Franklin County, owing to the absence of the oxyd of iron, the red color is wanting, as at St. Albans, where the rock is magnesian, and of a greenish-black or dark-brown color, very compact and hard to break. The best developments of this rock possessing the requisite characteristics for marble, are found in the towns of Colchester, Milton, Georgia, St. Albans, and Swanton. In these towns the rock possesses a great diversity of color, red being the most prevalent, and long unbroken ledges are found, which, when the wants of the country demand a more general use of ornamental marble, will yield inexhaustible supplies, equaling in beauty, and excelling in durability, the highly-prized oriental marbles of ancient or modern times.

Winooski marble usually occurs in beds, easily separable at the "bed-seams," but there are places where the stratification planes are wholly obliterated. Such is the case with the brecciated variety called "Mosaic marble," from its resemblance to artificial Mosaic work. This usually has a reddish color, and for many purposes must be regarded a valuable and very beautiful marble for ornamental work. Upon examination, it is found to be principally composed of fragments of stratified rocks, varying in size from a barley-corn to blocks a foot or more in diameter, which appear to have been promiscuously piled together, after which they were cemented with a substance having much more lime in its composition than the fragments themselves. This cement has a lighter color than the other portions of the mass, which gives it the beautiful sparry and variegated appearance which is observed in the Mosaic marble. It equals in beauty the artificial Mosaic work of Herculaneum and Pompeii, and is equally interesting to the man of thought, when he looks upon it and contemplates the changes that must have been wrought upon the crust of the earth, to thus reduce to fragments, and collect together again, such masses of the shivered rocks. The angles of the fragments are generally sharp, which proves that they were not transported far by water, but remained in a quiet state, in tranquil water charged with a calcareous substance, which, upon being deposited, filled the cavities, and converted the whole again into a solid mass.

An excellent outcrop of the Winooski marble is found at Mallet's Head, in Colchester. The strata at this point are nearly horizontal, and in many places form the bank of the lake. One of the best quarries is so situated that a vessel can be brought up alongside, and loaded with blocks, with as much ease as they are usually loaded upon carts or cars at inland quarries. The marble occurs in beds or strata, varying in thickness from one to six feet, and being a good marble to split across the bed or *grain*, blocks of any required size can very readily be obtained. The marble is susceptible of a high polish, and will resist, in a remarkable degree, the corroding influence of atmospheric agencies. Its composition, as determined by an analysis by C. H. Hitchcock, Chemist of the Geological Survey, is,

Carbonate of lime, ...	35.31
Carbonate of magnesia, ...	42.23
Silica, ...	10.30
Alumina and iron, ...	12.25
	100.09

This marble is hard to work, and consequently, when polished, is hard to deface by scratches or acids, and this fact of its hardness should attach to it additional value. Its color seems to admirably fit it for the purposes of ornamental work, for pier and center tables; and no marble can excel it in color or durability. The rich colors of the rose-wood or mahogany frames do not excel, in beauty or variety, those to be found in a slab of the Winooski marble. A few openings have been made in Colchester, and one recently near the south line of Swanton, but quarries of this marble have never been extensively wrought. With the increased facilities that are likely to be presented for working hard marbles, the Winooski will not be neglected, but will doubtless be successfully worked, and yield a rich reward to those so fortunate as to own a quarry.

George Barney, Esq., of Swanton, is now preparing to work a quarry near the south line of his town, and it is to be hoped that he will succeed in the laudable enterprise of bringing this valuable marble into notice, that it may be properly appreciated by the American people. Monumental shafts of this marble can be raised from the quarry, worked to the desired shape, and polished with greater facility than from the red Scotch granite which is so beautiful; and specimens of the former can be obtained, which would so closely resemble the latter as to require a close examination to distinguish one from the other. Beautiful specimens of this marble from Colchester and Swanton are now upon exhibition in the State Cabinet, which were donated by Hon. David Read and George Barney, Esq.

PLYMOUTH MARBLE.

The variegated marble of Plymouth seems to be of a distinct class, and by analysis, as determined by T. Sterry Hunt, Esq., of the Canada Geological Survey, is found to be a dolomite, composed of

Carbonate of lime, ...	53.9
Carbonate of magnesia, . . .	44.7
Oxyd of iron and alumina, . . .	1.3
	99.9

Unlike most dolomites, this marble resists the action of atmospheric agencies in a remarkable degree, and is durable when exposed to the weather. It is susceptible of a high polish, and were it a foreign production, would doubtless be highly prized as an ornamental marble.

It occurs in the talcose schist formation, near the center of the town of Plymouth, at an elevation of about two hundred and fifty feet above Plymouth Pond. It is well situated for drainage, and about six miles from the Ludlow railroad station. This quarry was opened about twenty-five years ago, and was worked for awhile; but as white marbles were in demand, to the exclusion of all others, at that time, the enterprise was abandoned, and the quarry has been used since only for the purpose of obtaining material for the manufacture of quicklime. Having in its composition less than fifty-four per cent. of carbonate of lime, still being of a compact structure, it produces, when burned, a nice quicklime, known in the market as the "Plymouth White Lime."

The beds have a strike N. 10° W., and dip 60° E. The walls of the quarry which have been exposed to the abrading agencies of frost, rain, &c., seem unaffected by the exposure of twenty years, which is conclusive proof of the durability of the marble when placed in exposed situations. Even its mottled appearance, produced by the light-colored blotches, that resemble fragments of a branching coral, inlaid in the rich blue ground-work, still stand out beautifully, and exhibit their peculiar markings upon the walls of marble in this abandoned quarry.

This marble is very easily worked for one so fine-grained and compact, and splits with nearly equal facility in all directions. An inexhaustible supply of it exists at this place, and it is but reasonable to suppose that this will, at no very distant day, be reckoned among the valuable marble quarries of the State. The marble and quarry are thus described by Prof. Frederick Hall, who visited Plymouth in 1838. He says:

"The marble, when polished, is exceedingly ornamental. The critical observer will, I think, see in it some feeble evidences of its having originally been formed of organized matter. Its ground is blue or bluish-brown, and diversified with long stripes and figures, of various shapes, in white. I have seen no marble of the same appearance in the United States. It bears a slight resemblance to a kind of marble said to be found in Tuscany, samples of which I have seen in the Vatican, at Rome, but I have forgotten its name. The quantity existing in Plymouth no one has the means of duly estimating. From what appears on the surface of the earth, and near it, I would say that a thousand quarrymen, constantly at work, and a hundred manufacturing establishments, always in operation, would not, for a century to come, materially diminish its amount."

Beautiful specimens of this marble have been presented by Isaac A. Brown, Esq., the proprietor of the quarry, and are now in the State Cabinet, at Montpelier.

ISLE LA MOTTE MARBLE.

The Isle La Motte marble is found in the Champlain valley, and was the first marble ever worked in the State. It derives its name from Isle La Motte, in Lake Champlain, where several quarries are now successfully wrought, some of which were opened prior to the Revolutionary War. It is nearly black, of a compact structure, and is susceptible of receiving a good polish. When sawed it makes an excellent marble for floor tiling, and specimens of it may be seen in the public edifices and costly mansions of the principal cities of our Union. It is found on many of the islands of Lake Champlain, and upon its banks in several places. A quarry was opened in 1851, and worked for a time at Larabee's Point, by the Shoreham Marble Co., but it is now abandoned. Button Harbor Island, west of Ferrisburgh, is mainly composed of the Isle La Motte marble, of excellent quality. It has never been used at this place as a marble, but is extensively quarried by some of the proprietors of iron works, in Essex County, N. Y., for a flux, to be used in their iron furnaces. From an analysis made by Prof. Olmsted, it is found to be composed as follows:

Carbonate of lime,	87.94
Carbonate of magnesia,	4.56
Alumina and iron,	2.60
Insoluble matter, mostly silica,	4.80
Water and loss,	.10
Protoxyd of manganese,	trace.
	100.00

Associated with the Isle La Motte marble, there are large and valuable beds of Chazy limestone; and although they do not possess the jet black color, and are not susceptible of receiving as good a polish as slabs of the former, yet the facility with which they can be quarried, and the ease with which the strata can be split and wrought into blocks, render them valuable for the purposes of a building stone, and in the construction of abutments and piers for bridges. In the gigantic work of building the Victoria Bridge* at Montreal, Isle La Motte contributed a large quantity of stone necessary in its construction.

During the years 1857–8 there were furnished from the Fisk quarry, upon that island, nearly 500,000 cubic feet of stone, much of it being worked to the desired shape before it was shipped. The two preceding years there were supplied from this quarry 520,000 cubic feet, the raising and cutting of which gave constant employment to about one hundred men. The machinery used by the Messrs. Fisk, in removing the stone from the quarry to the place of working the blocks, and to the vessel, seemed the most perfect in design, and effective in execution, of any we have ever seen. To describe the "travelers and jennies," and the *modus operandi* by which they are made to accomplish the multifarious duties required, would be a difficult task; but it will suffice to say that, with their aid, two men will remove, turn over, or pile up blocks, of many tons weight, with great expedition, and apparent ease.

To give an idea of the amount of stone in the quarry, and the quantities shipped from it, we insert a statement made by the proprietors to Prof. Adams, who was then State Geologist, which is as follows:

"Statement of the kinds of stone in Fisk's quarry, at Isle La Motte, commencing at the top of the quarry:

Top stratum,	1 foot high.	
2d "	5 feet "	
3d "	0 "	10 inches high.
4th "	4 "	2 "
5th "	2 "	2 "
6th "	3 "	0 "
7th "	2 "	0 "
	18	2

"Then comes on ten feet of gray limestone, and then ten feet of light-gray limestone, making in all thirty-eight and two-twelfths feet of quarry breast. The above strata can be cut with wedges to any dimensions to suit the market. The upper strata have been most worked in, and a very large quantity has been shipped to Canada within a few years. For fortifications and barracks on the Isle aux Noix, it took 484,000 cubic feet; for the locks on the Chambly canal, 136,000 feet; for foundation to barracks at St. Johns, about 20,000 feet; and the last season for abutments and piers to bridge over the Richelieu River, at Chambly, 12,095 feet, and 10,000 feet for the fort at Rouse's Point, N. Y. For the last ten years there has been sold to average about 6000 feet annually of blocks that are sawed into hearths and sent to New

*In 1858 there were 3281 men employed at the Canada Works, Birkenhead, in making tubes. Five steamers, sixty-two barges, twenty-one scows, and twenty-seven ferry and row boats, one hundred and forty-two horses, three locomotives, seventeen pumping, hoisting and stationary engines, and two riveting machines, were employed on the work. The total length of the bridge over the St. Lawrence is two miles, less one hundred and fifty feet. It is iron and tubular, and consists of twenty-three spans of two hundred and forty-two feet each, and one in the center of three hundred and thirty feet. The spans are terminated on each side by causeways terminating in the abutments of solid masonry, two hundred and forty feet long and ninety feet wide. The northern causeway is 1400 feet long, and that on the south seven hundred feet. The bridge is built for the use of the Grand Trunk Railway through Canada.

York, Boston, and Philadelphia. These blocks we sold for twenty and twenty-five cents per cubic foot. When sawed into hearths, each cubic foot makes seven superficial feet of hearths. The average price in New York of hearths has been about thirty cents per foot.

We have also shipped during the above time, large quantities of building stone, posts, caps, sills, &c., for various buildings in different places, some of which may be seen in the jail and private buildings in Burlington, and in almost every other place of note on the lake. We this year have a contract to furnish 40,000 cubic feet for abutments and piers for the St. Lawrence and Atlantic rail-road bridge over the Richelieu River near Belœil.

We pay eight and one half cents per foot for transportation, about half a cent for duties and canal toll, and receive twenty-one cents per foot delivered at the bridge. The expense of quarrying it is six cents, leaving a net profit of six cents on every foot. The hearth blocks give a profit of twelve and one half cents per foot. We pay our men from eighty cents to one dollar and fifty cents per day. The price for cutting stone for building is three and one half cents per superficial foot, which is not included in the stone above, as they are delivered in the rough state and cut at the expense of the purchaser.

HODGSON & FISK."

To Professor C. B. Adams.

VERD-ANTIQUE MARBLE.

The Verd-antique marble, so called, is serpentine or ophiolite, and is quite abundant in the State. As its name would indicate, the prevailing color is green. In the same specimen it has every shade of green, from white to a greenish-black, all tastefully blended together; and it is this array of shaded color that contributes to its unsurpassed beauty. In structure it is very fine-grained and compact, and its composition is such as to render it unaffected by acids. It effectually resists the decomposing agencies of heat and moisture in summer, and the disintegrating influence of the frosts of winter. Its durability is unrivalled by any other rock used for architectural purposes.

The Commissioners appointed to test the material used in the construction of the extension of the Capitol, at Washington, subjected twelve varieties of rock to the crushing force of Wade's Proving Machine. These tests proved the Verd-antique marble to be the best to resist pressure, of any tried, for while this withstood a pressure of 26,429 lbs. to the square inch, the next toughest variety endured a pressure of only 23,917 lbs., and some specimens withstood only 7,153 lbs. to the inch. From the foregoing it will be apparent that with all the indestructible traits possessed by the Verd-antique marble, it must be hard to work. It, however, can be sawed with a thin plate of soft iron, continually supplied, during the sawing motion, with water and sharp sand, and after it has been smoothed down to a perfectly plane surface, it receives an exquisite polish at comparatively little expense.

Until within a few years it has been considered a very difficult task to give serpentine a rich, glossy finish—but at Roxbury, Vt., a new polishing material was discovered, and applied, which enabled the workmen to give a remarkably fine finish with but little labor or expense. Actinolite—a bright-green mineral, a variety of hornblende that is usually found associated with the serpentines and soapstones of Vermont—is found to be far superior to "tin putty," or any other material yet discovered, for polishing Verd-antique marble. To prepare the actinolite for polishing, crystals of it are taken and reduced to an impalpable powder, which is put into water and thoroughly stirred. The water, which holds in suspension the fine powder, is poured off from the coarser particles into clean

vessels, and suffered to stand undisturbed till the powder is deposited in sediment at the bottom. The water is then carefully poured off, leaving the sedimentary substance at the bottom, which is the "paste" used for giving the Verd-antique marble its rich polish.

The composition of serpentine is variable. In the same specimen the white veins are usually found to be composed of substances different from those of the darker portions, and varieties examined from different portions of the State are found to be essentially different in their composition. Thus, for example, the serpentine of Cavendish contains not a trace of lime, while that of Roxbury has, in the light colored portions, 15 per cent. of it. The following table exhibits the composition of specimens obtained at Cavendish and Roxbury, and also those from Europe.

	Cavendish.	*Roxbury.*		*Europe.*	
	Light and dark together.	*Light.*	*Dark.*	*Light.*	*Dark.*
Silica,	43.34	1.50	42.60		42.40
Magnesia,	39.55	80.00	35.50	11.70	31.20
Protoxyd of Iron,	5.32	3.50	8.30	7.30	13.90
Water,	11.79		13.00		12.50
Carbonate of Lime,		15.00	.60	81.00	
	100.00	100.00	100.00	100.00	100.00

The Verd-antique of the ancients, and that of Europe, which in Germany and Spain is now wrought into table-tops, pillars, pilasters, &c., has in its composition much more lime than in varieties found in Vermont, hence it is softer and more easily worked, but when placed in exposed situations, it is less durable than that in which less lime is found.

Two quarries of serpentine have been opened and worked in the State—one at Cavendish and one at Roxbury; but in consequence of the great expense of quarrying and working it, the difficulty in selling it for remunerative prices, want of sufficient capital, bad management, or for some other cause, both quarries are now abandoned. They are both favorably located, the one at Cavendish being within a few rods of a good water power, upon Black River, and less than one-half mile from the Rutland and Burlington Railroad; and that at Roxbury is within thirty rods of the Vermont Central Railroad.

The quarry at Cavendish was the first worked in the United States, having been opened more than twenty-five years ago, before a railroad in Vermont was ever *contemplated*, and evidently before the wants of the community demanded a marble as expensive as the Verd-antique. The work of polishing was attended with much expense, and was but indifferently done, as will be seen by the following extract from the pen of Prof. Frederick Hall, who visited the works in 1838, and describes them. He says:

"These articles (mantels, table-tops, &c.) present a splendid appearance, particularly when moistened; but, I regret to say, they are not highly enough polished. The American workmen are novices at the business, and too sparing of their labor. They have not the patience, the perseverance, nor perhaps the skill and taste of the Italians. The serpentine is of good quality, and susceptible of as high a polish as that ordinarily employed by the ancients, and is not unlike the beautifully polished fragments which the traveler meets with among the ruins of the ill-fated Pompeii, and in the remains of the Mosaic pavement at Adrian's villa, near Tivoli. The quarrying is not difficult. The rock rests upon elevated land, hence there is no *up hill* work to perform. The block is easily rent from its present bed by the force of gunpowder, and drawn by oxen down to the mill, which is but a few rods distant."

In this last sentence may be found the reason why so many specimens of serpentine worked by the "Black River Marble and Soapstone Manufacturing Company," were unsound. Gunpowder was doubtless the cause. It was formerly much used by those who worked marble quarries, but it is now found to be very injurious—seriously affecting the soundness of the blocks—hence its use is discontinued, except in the removal of worthless rock. The same course should be pursued in working a quarry of serpentine or Verd-antique marble. Specimens of polished serpentine from Cavendish, which were presented by Isaac A. Brown, Esq., of Proctorsville, are now upon exhibition in the State Cabinet.

In Roxbury the American Verd-antique Marble Company worked a quarry which was favorably located, with a steam mill for sawing the blocks erected a few rods distant, alongside the Vermont Central Railroad. For a time the work was vigorously carried on, but, like many worthy enterprises requiring a large investment of capital before there is a return of profits, the project was abandoned too early to have its merits fully tested; and in consequence of a financial "panic" that swept over the country a few years since, the work was suspended in 1858, and has not been resumed. At present quarries of Verd-antique marble are not worked, but it is to be hoped that a greater demand for the article will soon be created, and such advances made in the arts as to enable men to work the serpentine with the same ease and facility that common white marble is now worked, when both quarries, and perhaps others in the State, will again be opened and successfully wrought.

Many beautiful specimens have been sent abroad from the works at Roxbury, among which may be noticed the blocks forming the pedestals of the statues of Franklin, in Boston, and of Warren, on Bunker Hill. Cubical blocks of it were presented to the State by David McKane, Esq., and are now in the State Cabinet.

By referring to the Geological Map (Plate I.), it will be seen that many outcrops of serpentine occur in the State, but none more favorably situated for working than the two named. They are generally found in the eastern limits of the talcose slate, extending from Massachusetts to Canada; and it often forms the dividing line between the talcose and mica slate formations. It is near this line that the gold of Vermont is found.—Wherever the talcose slate is found east of the serpentine (or soapstone, which is generally associated with it), gold is usually found, but seldom, if ever, in workable quantity, except there be a deep, eroded valley in the immediate vicinity, with an open slate rock at the bottom for a "bed rock," in the cavities of which the gold is found.

HYDRAULIC LIMESTONES.

These embrace such impure limestones as will, upon being calcined, pulverized, and mixed with proper proportions of sand, harden under water. Impure limestones, possessing the constituents that enter into the composition of hydraulic limestone, are quite abundant, but we have not had at hand the facilities that would enable us to determine, beyond a doubt, the exact position and extent of the valuable varieties in Vermont. The known composition of our silicious dolomites strongly favors the conclusion that valuable water limestone exists; but notwithstanding the successful efforts of chemists in

determining the composition of hydraulic limestones, none have been able to determine with certainty the essential constituents necessary to produce solidification under water; and it is only by actual experiment that the relative value of different limestones for hydraulic mortar can be determined.

When limestones produce quicklime by calcination, that will crumble upon exposure to the atmosphere, and upon the application of water will readily evolve great heat, swell up, and fall to powder, it may be safely inferred that they are unsuitable for water-lime purposes: but upon the contrary the limestones that produce mortar which will acquire a stony hardness under water, when calcined undergo very little apparent change upon exposure to the air; and upon the application of water, there is not an evolution of much heat, nor do they readily slake,—but when pulverized and mixed with sand and water, suitably proportioned, soon become a solid mass. Water-limes generally become the most thoroughly solidified when placed under standing water, but some varieties—the Roman cement for example—will harden almost instantaneously upon being mixed with sand and water whether it be placed under water or not; and like plaster of Paris, no more should be mixed than is wanted for immediate use.

The Rosendale cement of Ulster Co., N. Y., so much used in Vermont, is from an impure limestone that is doubtless obtained from a continuation of the Eolian limestone formation; and from an analysis of the rock by Prof. L. C. Beck, is found to contain:

Carbonic acid,	34.20
Lime,	25.50
Magnesia,	12.35
Silica,	15.37
Alumina,	9.13
Peroxyd of iron,	2.25
Bituminous matter, moisture and loss,	1.20
	100.00

This rock upon being properly calcined is deprived of most of the carbonic acid contained in it, and the cement is found to contain:

Carbonic acid,	5.00
Lime,	37.60
Magnesia,	16.65
Silica,	22.75
Alumina,	13.40
Peroxyd of iron,	3.30
Loss,	1.30
	100.00

From the foregoing analyses, it will be seen that much silica and alumina enter into the composition of the cement, and they are doubtless ingredients essential to its hardening properties. If so, it occurs to us that the value of dolomitic lime would be much augmented for hydraulic purposes, if calcined clay—to furnish the requisite amount of alumina and silica—was mixed with the lime before making it into mortar. It is a well-known fact that the dolomitic lime of Plymouth, Cavendish and Weathersfield, makes a mortar that is much more durable for situations exposed to moisture and the weather, than that made from the pure carbonate of lime, and it seems reasonable that if silica and alumina were added in the form of sand and calcined clay, the lime thus treated would become hydraulic. In Italy, pozzuolana, a volcanic product, containing 44.5 per cent. of silica, and 15 per cent. of alumina, when pulverized and mixed with lime, produces a good hydraulic cement. May we not profitably copy from this, and instead of procuring the calcined substance from the volcano, substitute in its stead an equivalent that shall have been prepared by artificial heating? But beds of magnesian limestone, interstratified with the purer carbonates of lime, are very abundant in nearly all parts of western Vermont, and upon their weathered edges there is evidence that silica and peroxyd of iron enter into their composition; and unless we greatly err in our opinion, a majority of the silicious dolomites found in the range of Eolian limestones in Vermont, are of such a character as to make excellent hydraulic cement, if properly treated.

To obtain lime for water cement, the impure limestone should be broken into small pieces, and subjected to a heat sufficient to expel the carbonic acid, which will require a high heat from two to five days. But care must be taken that the heat is not too intense, for if it is, the rock will become partially fused, and a glassy substance will result from the alkaline and silicious constituents of the rock. After calcination, the rock should be thoroughly pulverized and mixed with sharp sand, after which water may be applied till the mass assumes the consistency of common mortar, when it should be used immediately, especially if it possesses the *setting* property of some cements. The proportion of sand to be used with the cement, varies with the composition of the lime. When the rock is strongly charged with silica, less sand is necessary than where silex is less abundant. The cases are very rare where the proportion of sand should be less than that of the lime, and in a majority of cases the work is better for having two or three parts of sand to one of lime. Mr. Benj. Livermore, of Hartland, who has experimented with, and successfully used considerable water cement in the construction of water aqueducts, uses the following proportions:

Cement, ...	1 measure.
Sand, ...	$1\frac{1}{2}$ measures.
Gravel, ...	2 measures.

He says, in his pamphlet of directions for the manufacture of his Patent Drain Tile or Water Conduits, after giving these proportions, that

"These ingredients should be thoroughly mixed together in a dry state, the cement and sand first, then add the gravel. For this purpose, a box that will contain two or three bushels should be provided. As the mortar should be used within about fifteen minutes after being wet up, a box that will contain about half a bushel is most convenient for this purpose. Into this smaller box put a quantity of the mixture, add water, and mix it up with a hoe until it is about the consistency of plastering mortar, and use it immediately. It must be used immediately, for, if allowed to remain long enough to set, on being again worked up its properties of hardening will be in a great measure destroyed."

In order to have most kinds of hydraulic cement become hard and durable it should be kept wet for many days, or even weeks, for it is unlike common lime mortar in this respect, and does not readily harden. When suffered to dry rapidly, it does not acquire

the hardness requisite, but easily crumbles. In the construction of locks, dams, flumes, &c., water cement is invaluable, and may also be profitably used in exposed situations, upon buildings, for cellar bottoms, &c.

STEATITE OR SOAPSTONE.

Steatite is known by various names, the most common of which is soapstone. *Freestone* — from the facility with which it can be cut; *Potstone* — it having been used for culinary vessels by the aborigines; and *Chalkstone*—from its leaving a trace like chalk—are names that are also applied to it. It usually has a gray or greenish-white color, arranged in veins or clouds, and occurs massive, with oftentimes a subcrystalline structure that presents dendritic delineations upon the surface. It has a dull luster, a splintery fracture, is unctuous to the touch, easily cut with a knife, and is translucent on the edges. It is composed principally of magnesia and silex, but alumina, iron and chrome enter sparingly into its composition. The uses to which it is applied are numerous and varied. The facility with which it can be wrought, renders it valuable for architectural purposes, and its capability of resisting heat makes it very valuable for lining furnaces, limekilns, stoves, fireplaces, arches, &c. When reduced to powder it is efficacious in removing grease spots from clothes, by absorption, and in many cases it is advantageously used for lubricating machinery.

Steatite is an abundant mineral in Vermont, and is usually found associated with serpentine and hornblende. It occurs in beds instead of continuous strata, and the beds usually have a great thickness, when compared with their length. It not unfrequently happens that several isolated outcrops occur on the same line of strata, sometimes several miles apart, and in many cases steatite beds are found to alternate with beds of dolomitic limestone that are scattered along in line with them. Most of the steatite is found on the east side of the Green Mountains, and near the eastern line of the talcose slate formation, and beds of it are found nearly the entire length of the State.

In the town of Marlboro there are several beds of steatite — generally known there by the name of chalkstone. The most southern, and probably the most valuable bed, is upon the land of H. O. Ballou, Esq. With it are associated serpentine and chlorite. The outcrop of soapstone and serpentine is about twenty-five rods in length, and from one to four rods in width. The best development of soapstone is at the southern extremity, from whence were taken several blocks, years ago, and used in the construction of fire-places in the vicinity. Crystals of rhomb spar* and iron ore, with occasional veins of quartz, are found in the soapstone, and not only render it hard to work, but seriously impair its value if it is to be placed in situations where it will be subjected to intense heat. The bed occurs in chloritic and talcose slate, and has a strike N. 20° E., with a dip 50° E.

About one mile north of the last named bed, and on the same line of strata, there is another one, on the land of Ward Bellows, Esq. It is in the valley of a small stream, and probably too low, and the deposit of good stone too limited, to afford a quarry that can be worked with profit. The dip and strike of the bed are the same as the last described.

*Rhomb spar is composed of carbonate of lime (52), carbonate of magnesia (45), and oxyd of iron (3.) From this it will be seen that steatite containing much of this spar will not be valuable for a fire-stone.

About three miles further north, on the land of C. Worden, Esq., another bed is found which is about twenty rods in length and from one to four rods in width. Only a small proportion of the rock is suitable for working, as in it so much brown spar and other impurities are found. The bed is well situated for drainage, and in it may be found some good soapstone. Much chlorite and chloritic slate are found associated with it. The bed conforms in dip and strike with the talcose slate inclosing it, which has a strike N. 10° E., and dips E. 50°.

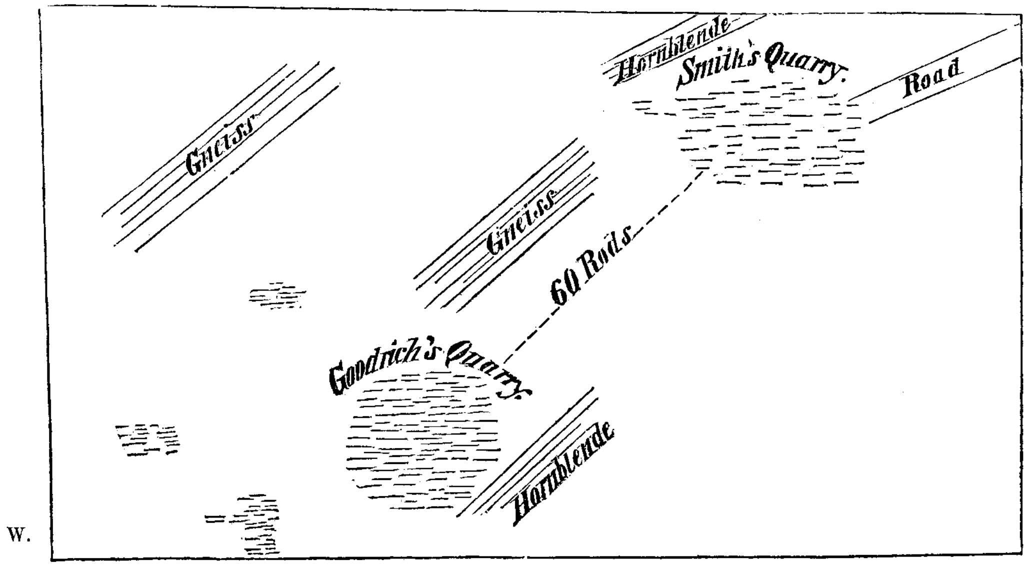
In the north-western part of the town of Newfane, is found the quarry owned and worked by the "Vermont Marble and Soapstone Co." At this place there is an extensive outcrop of serpentine and soapstone — the former being much the more abundant. Like the outcrops before named, this soapstone is injured by the impurities of spar, talc, actinolite, iron, &c.

In working beds of soapstone associated with serpentine — as the one under consideration is — there is great uncertainty as to its extent, or the continuance of pure stone, fo large outcrops are oftentimes suddenly *pinched out* by the walls of serpentine that inclose them. Again, the soapstone not unfrequently passes into and forms an impure serpentine, which from its hardness is rendered unfit to be cut with a saw having teeth. Some very nice specimens of soapstone have been obtained from this quarry, but the expense of removing the superincumbent rock, and the large quantity of impure stone obtained, may prove so detrimental to the interests of the company as to induce them to abandon the enterprise. The bed is encased in talcose slate and serpentine, and has a strike N. 15°E., and dips 77° E.

On the farm of David Bemis, in the east part of Townshend, there is a deposit of soapstone that was worked several years since, but is now abandoned. Rock was removed to the depth of twenty-five or thirty feet, but being upon comparatively level land, it was unfavorably situated for drainage, and the stone being considerably filled with impurities, it was deemed best to abandon it. The deposit does not appear to be a large one, and the inducements presented in the appearance of the rock and its surroundings, are not such as should induce one to make a large investment there, with the hope of returning profits. This bed occurs in gneiss which has a strike N.E. and S.W., with a dip 50° S.E. By referring to the Geological Map (Plate I.) it will be seen that this bed is on a line with the bed of dolomitic limestone in Athens, and the celebrated soapstone quarries in the south part of Grafton, and it is a noticeable fact that all these deposits occur in gneiss, with black mica, hornblende, talc, actinolite, &c., associated with each of them.

The quarries of Grafton — or Grafton and Athens, for the soapstone extends into the latter town — have been worked longer, with more profit, and have produced more stone than any other soapstone quarry in Vermont. More than forty years ago they were successfully worked, and furnished window caps and sills, fireplaces, pipes for aqueducts, &c. There are two principal quarries, one being known as the Smith quarry, and owned by the heirs of the late Benjamin Smith; and the other, which is about 60 rods south-west, is called the Goodrich quarry. The former which now produces about 400 tons of good stone per annum, is leased to Messrs. Butterfield & Smith, who are raising the stone, and sawing it with a common mill saw, in a mill in Cambridgeport.

FIG. 329.

W.  E.

Steatite Beds in Grafton and Athens.

The relative situation of the Smith and Goodrich quarries may be seen in the above cut (Fig. 329.) The stone from the Goodrich quarry is mostly taken to a mill at Saxton's River Village, and sawed. The beds in these quarries have a variable dip, averaging about 25° N.W. In the Smith quarry, stone has been removed from over a surface ten rods in length and six rods in width, and in some places it has been excavated to the depth of twenty-five or thirty feet. The soapstone occurs in what appear to be stratified beds, the edges of which are now shown in the sides of the quarry. In them are plainly seen the seams of rhomb spar and talc, that extend along in lines, or are disseminated through them in small imperfect crystals, which upon long exposure become decomposed and wash out, producing a tarnished surface upon the face of the rocks below. Immediately upon the soapstone is found black mica and a shaly talc, and in the latter a dark-colored actinolite. Next above this, there is a bed of hard compact hornblende, which is in some places six feet in thickness, and has proved a complete protection for the soapstone against the attacks of atmospheric agencies that produce the decomposition or disintegration of such soft rocks as are long exposed to their influences. The Goodrich quarry has been worked, and stone removed from an area of about eighty square rods, and to the depth of about twenty feet. The overlying rocks, which are nearly conformable with the soapstone beds, have a dip of about 25° north. In the south-east side of the quarry the following is the order of rock :

Commencing at the top, there is a bed of compact gneiss six feet thick. Next below this is a disintegrated talcose slate, varying from a few inches to three feet in thickness ; and between this and the upper bed of soapstone, is a stratum of talc several inches thick which occurs in broad plates, with crystals of actinolite in it. A bed of soapstone about four feet thick is next met, below which there is a bed of compact hornblende of about the same thickness, which rests on another bed of soapstone that is about four feet thick. Before much more soapstone can be obtained from these quarries, it is evident that much money must be expended in removing the superincumbent rock. The immense amount of rock that has been blasted out from these quarries, and lies around them,—much of it hornblende,—shows that the fortunes realized from their products were not obtained without persevering effort, and heavy investments of money to defray the expense of quarrying. But most of the soapstone obtained has been of the finest quality, and consequently met with a ready sale, which fully explains why they have proved so profitable. Cubical specimens that were presented by the proprietors of these quarries, are upon exhibition in the State Cabinet at Montpelier.

Near the south line of Windham, on the land of Simeon Pierce, Esq., is a small outcrop of soapstone. It occurs in an impure serpentine that contains a great amount of rhomb or bitter spar, and has been called by some, soapstone. The surface is comparatively soft in consequence of the partial decomposition of the rock, but it is found upon penetrating it to be an impure serpentine. In the midst of this impure rock at the south end of the outcrop, there is a vein of very pure and fine-grained soapstone, or perhaps more properly agalmatolite. It is about six feet long, and three feet wide in the widest place, and runs to a point as shown at G, Fig. 285, page 538 of this Report. Near this outcrop there is a fine locality of actinolite, where have been obtained many excellent specimens. This outcrop—which appears to be an *outlier* of a large deposit of serpentine about seventy rods west of it—is encased in talcose slate, which gives evidence of great local disturbance, as will be seen by referring to the cut (Fig. 285.) North-east of the village of Windham efforts have been made to quarry soapstone, but, like that found in the south part of the town, much of it approaches nearer to serpentine than to soapstone; and when masses of the latter occur, there is generally found in it so much spar and other impurities as to render it valueless.

Soapstone is found in the south part of Chester, but has in its composition too much spar to prove valuable for a fire stone, or desirable to use for architectural purposes.

In Cavendish, about one half a mile west of Proctorsville, there is a large deposit of soapstone which several years ago was worked by Ilock Hill, Esq. The occurrence of spar in it is the reason why it has not been more extensively quarried, for it is near a good water power and well situated for quarrying. Specimens of the stone that was used for architectural purposes twenty years ago, fully attest its durability and value. Deposits of considerable extent are found that are free from spar or other foreign impurities, and stone of a superior quality is found in them. An outcrop of this kind is found on the land of Rev. Joseph Freeman, near Proctorsville.

Prof. C. B. Adams thus describes the deposit in Cavendish:* "The soapstone lies on the west side of the serpentine,—with a few rods of mica slate intervening, which occupies a space of about ten rods wide on the main road from Ludlow to Proctorsville. The soapstone is several rods wide and the quantity is inexhaustible. Much of it is undoubtedly of excellent quality, and being on the route of the Rutland railroad is worthy of careful exploration."

In Mount Holly, near Ludlow line, on the land of Levi Lawrence, there is a small bed of soapstone associated with dolomitic limestone. The strike of the rock—inclosing the beds of soapstone and limestone, both of which are small and lie adjacent—is N. 20° E., and dips E. 65°. There are impurities in both beds, rendering them slaty, and probably neither are valuable.

*See Second Annual Report on the Geology of Vermont, p. 239.

In the town of Weathersfield—one mile from Perkinsville, and near the line of Baltimore—is located the quarry now owned and worked by the "Windham County Mining Company." This, like the Grafton quarries, is situated in the gneiss formation, and not far distant from the line of strata in which are found the beds of dolomitic limestone.—But unlike the quarries in Grafton this has no hornblende rock overlying the stone, but an immense bed of sound soapstone is found with no rock encasing or lying upon it, and all that is required to reach it is merely the removal of the overlying earth.

About ten years ago this quarry was "leased" to parties who worked it upon a small scale, but not sufficiently to thoroughly test its value, and the lease was suffered to expire, and the quarry was abandoned, with the idea that it would not prove valuable to those working it. It was then purchased by the present company who commenced operations there in 1857, since which time the work has been successfully prosecuted under the superintendence of George W. Kenney, Esq., who seems in every respect fitted for the responsible position which he holds. About ten rods east of the quarry a steam mill is erected, in which there is an engine of twelve horse power for carrying the saws and machinery used in sawing posts, window and door caps, slabs for export, and those used for manufacturing register frames, stove linings, cake griddles, &c., which are manufactured to order at this establishment. It is estimated that there were raised from the quarry last season (1859) about 800 tons of stone, of which about 300 tons were sent off to the markets of Boston, Providence and New York. There is an inexhaustible supply of stone that is of a superior quality, and remarkably free from foreign impurities so commonly found in other quarries.

With the well known fact that the quarries at Grafton have yielded a reward for labor that has made all the owners of them rich, the conclusion irresistibly forces itself upon our mind, that with proper management this quarry will prove more valuable than any heretofore opened in the State, and amply compensate those who have had the good fortune to secure an interest therein. Specimens of this stone are to be seen in the State Cabinet, which were donated by the agent of the company.

[Since the foregoing was written, another quarry, which has furnished some valuable soapstone, has been discovered about one-fourth mile east of the one last described. In this quarry there is found a gneissoid rock that covers and encases the bed of soapstone. Stoves are now (1861) being manufactured from the stone obtained from this quarry, by Hyren Henry & Co., which find a ready sale. The stone obtained at this quarry is of excellent quality, and the quantity is supposed to be inexhaustible.]

In the south-east part of Plymouth, about one half mile from the meeting-house on the "society lot," is a deposit of soapstone, which was quarried many years ago, and used in the construction of fireplaces, window caps, &c., but is now abandoned. It has a strike north andsouth, and dips 50°E. The deposit does not seem to be extensive, and joints are so numerous in it that it is difficult to obtain large blocks that are sound.

Further north, in Plymouth, between the gold diggings on Buffalo Brook and those on Gold Brook, upon the land of Martin Pelton, there is a small outcrop of very pure soapstone that occurs interstratified with the talcose slate. North of this, on the same line, there are several small outcrops, on the land of Alason Bates and Jared Marsh, Esq., but in it there are sprinklings of brown spar that greatly impair its value. Outcrops of soapstone are also seen near the gold washings at "Five Corners," but probably no rock of workable quality could be obtained there. One of the outcrops on Mr. Marsh's land is quite extensive, and may prove valuable upon removing the surface rock.

Near the center of the town of Bridgewater there is an immense deposit of soapstone—probably as large as any in the State. It is upon the land of George H. Bugbee, Esq., and near a good water power upon the north branch of Otta Quechee River. It is favorably situated for quarrying, being near the highway and upon elevated ground.

Many years ago soapstone was quarried at this place, and sawed in a mill near by into jambs for fireplaces, window caps, &c. In most of the old brick buildings of Bridgewater and Woodstock may be seen soapstone window caps, and frequently fireplaces, made from the stone obtained from this quarry. But for several years little stone has been sawed, and the quarry is used only for obtaining blocks wanted in the vicinity for fire-stone, or for making water cisterns, &c., none being quarried for export.

The reason it is not now worked is probably because of its distance from the railroad. To the Vermont Central railroad it is about eighteen miles down the valley of the Otta Quechee, and it is about equally distant from the Rutland and Burlington railroad station at Ludlow, which is reached from thence by a good road down the valley of the Black River, to which station stone could be transported at a cost of less than three dollars per ton. A fine specimen from the quarry is upon exhibition at the State Cabinet, which was presented by Russel N. Wood, Esq., who at that time owned the quarry.

In the northern part of the village of Bethel, on the land of Peleg Marsh, Esq., and in the highway, there is an outcrop of soapstone which extends ten rods in length, and is visible in spots more than one rod in width. It also appears on the south side of White River, on land of Rodney Shedd, and probably extends under his dwelling. Upon the north side of the river the stone has been quarried, but being found too hard to be worked easily with a common mill saw, it was therefore abandoned. We think the prospect of finding good workable stone is best upon the south side, near the end of the bridge; and should good stone be found there, it can be readily loaded upon the railroad cars with a derrick, directly from the quarry. In the western part of the town there is a bed of laminated talc in which is found actinolite, and some of the talc is sufficiently compact to be used for soapstone. But not having visited the locality, we refrain from giving an opinion of its value.

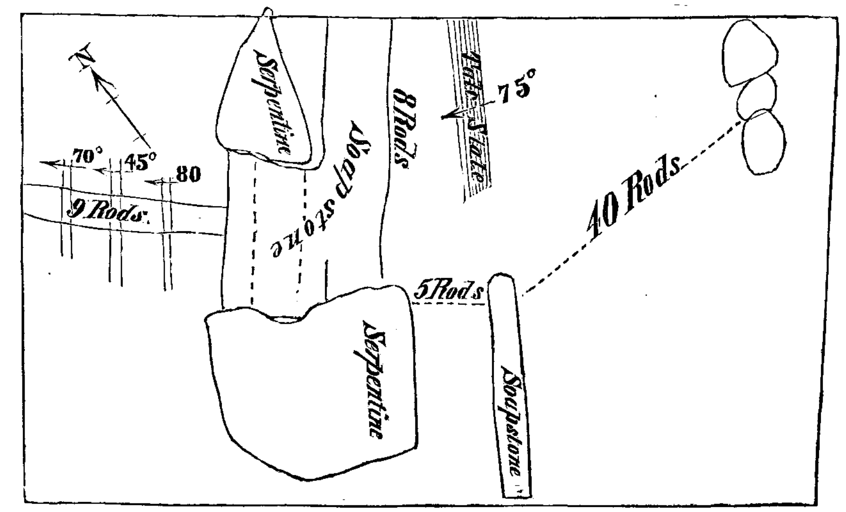
On the land of Jeduthan Taylor, in the east part of Thetford, there is a small deposit of soapstone, but in it are too many impurities to be valuable. It occurs where the strata are much broken and disturbed, and has a strike east and west, with a dip of 42° N.

On the land of William W. Williams, Esq., of Rochester, two miles east of the village, and about seven miles from the Vermont Central R. R., is located a soapstone quarry, which has been worked for a while by Messrs. Williams & Campbell, and stone taken therefrom to Saxton's River village, where it is sawed, and much of it used for the manufacture of refrigerators, for which it seems admirably suited. It is, properly speaking, agalmatolite, and has not the crystalline structure, or coarse texture usually found in soapstone. It is an excellent fire stone, and being perfectly free from spar or other foreign impurities, it can be easily cut and planed without impairing the edges of the tools used. The deposit is quite extensive, and in it there is great diversity of color, and considerable difference in the texture of the several beds. The soapstone is associated with, and in

some places seems to pass into an impure serpentine. The strike of the beds that are conformable with the strata of the talcose slate encasing them, is N. 10° E., with a dip of about 75° W. There are three deposits of soapstone within the circuit of forty rods, but only one — the most western — has been worked. An opening to this bed has been made upon the western side, and the first stone encountered in the bed is a black, compact soapstone, having a thickness of about two feet. Adjoining this on the east there is a valuable bed of variegated soapstone, which upon being smoothed and varnished, closely resembles a light-colored serpentine. Some beautiful specimens of this variety and others, were presented to the State by W. W. Williams, Esq., and are upon exhibition in the Cabinet.

The variegated stone is the most abundant of any in the quarry, and has a thickness of about five feet. Next beyond this is a bed of green soapstone that has a thickness of about two feet and somewhat resembles compact chlorite. The other two deposits alluded to are of limited extent, and probably would not prove as valuable as the excellent quarry just described. The following cut will exhibit the relative position and extent of the serpentine and soapstone at this quarry.

Fig. 330.



Williams' Soapstone Bed, Rochester.

In Roxbury and Warren there are a few small outcrops of soapstone in connection with the serpentine of those towns, but probably too much adulterated with foreign impurities to be valuable.

About one mile south-east of the village of Waitsfield, on land of Mrs. Orpha Joselyn, there is a bed of soapstone which has been worked, but is now abandoned. It is situated on a swell of land about one hundred and fifty feet above the village, and the associate rock, talcose slate, forms the summit of the ridge, and has strike N. 30° E., and dip 80° E. The bed is interstratified in the slate and extends several rods in length. Openings have been made, and soapstone has been removed at each end, to the depth of eight or ten feet. The bed is divided in the middle by a bed of impure serpentine or sparry soapstone, that is about ninety feet long, and in the widest place eight feet, running to a point at each end. The beds of soapstone on either side of this impure rock has a thickness of two to six feet. It has a laminated structure, and is free from foreign impurities.

On land of S. B. Pierce, Esq., of Duxbury, there is a small outcrop of soapstone, some of which is very pure. It is situated in the south-east part of the town of Duxbury, eight miles south of Waterbury, and about two miles from Moretown village. It has strike N. 20° E. and dips 80° E. The deposit is probably too small to be profitably worked.

On a line with the strata north from the last, there are several small outcrops of steatite in connection with serpentine, that occur near the town line of Duxbury and Moretown. Attempts have lately been made there to quarry soapstone, but, from the fact of the limited amount of good stone deposited, the enterprise has not proved profitable to those engaged. In one case the soapstone was found interstratified with the talcose slate. This deposit was situated near the highway in the north-west corner of Moretown, on land of William Davitt, Esq., two miles east of Waterbury village. An excavation has been made, and soapstone removed twenty-five feet in length, twelve feet wide, and about ten feet deep. About a dozen tons of soapstone were taken from this quarry, but as the quantity was so limited, and the facilities for draining the quarry were so unpropitious, the enterprise was abandoned. The strike of the bed is nearly north and south, and the dip is 78°E. The stone removed was quite pure,— at the north it passed into a sparry serpentine, and at the south into chlorite.

In Waterbury and Stowe there are several small deposits of soapstone, but none sufficiently extensive to induce a great investment of capital to work them.

In Waterville, north of the village about three miles, on land of S. & S. Hemmenway, there is a deposit of very fine soapstone, and worthy of further exploration. The strike of the bed is nearly north and south, and dips about 50°W.

Steatite beds also are found in Belvidere, Johnson, Eden, Lowell, Westfield, Jay and Troy, but we think they are invariably associated with serpentine, and occur in beds of limited extent. Their distance from a railroad would be a serious obstacle to success in working them, even if the deposits were extensive and the stone of good quality. But should the Passumpsic road be completed to Memphremagog Lake, this obstacle would, in a great measure, be removed.

Before concluding our remarks upon soapstone, we will make a few suggestions in relation to its use as a fire-stone. Its composition seems adapted, and experience has proved it to be one of the best substances in nature to withstand intense heat without injury.— When at the quarry of the Windham County Mining Company, in Weathersfield, we placed blocks of the stone in the fire under the engine boiler, and let them remain there till they had reached a white heat, upon which we took them out and threw them directly into cold water without the least injury to them, and producing no apparent change except giving them a yellowish appearance.

John Reynolds, Esq., the agent who superintends the smelting of copper ore at the furnaces in Strafford, at our suggestion made a trial of soapstone from the Weathersfield quarry, and used it instead of fire brick, in the furnaces, with results that were highly gratifying.

Messrs. Penniman & Noyes, of Winooski Falls, who manufacture large quantities of the celebrated *Winooski lime*, and have in use four or five perpetual kilns, have recently abandoned the use of fire-brick, and use soapstone instead of them in lining their kilns. It is found to be much more durable than the best fire-brick that can be procured.

In placing soapstone in situations exposed to intense heat, care should be taken to have the *edges* of the strata or laminæ exposed to the fire instead of the side surface, and as large blocks as possible should be used. If the edges are not placed next to the fire, there is not only danger that the fuel and other substances that come in contact will cleave off the exposed laminæ, but the intense heat more seriously affects the stone when thus exposed.

Again, when soapstone is first subjected to heat, it should be applied gradually, or there is danger that the water contained in it will be rapidly converted into steam, and the stone cracked in consequence. After the expulsion of the water by the application of heat, there is very little danger in subjecting soapstone to great heat, whether applied suddenly or gradually. A "Stone Franklin" stove, manufactured by the Tingley Brothers, from the Weathersfield stone, now warms the room in which we are writing; and although it has been subjected to great heat — still is uninjured by crack or blemish, and we can but believe that it will prove as durable as though it was made of iron.

ROOFING SLATE.

The roofing slate of Vermont is found to exist in three distinct divisions, occupying the eastern, middle and western portions of the State. The different ranges, although not exactly parallel, are found to extend in a direction varying but little from N. 10° E.

The argillaceous or clay slate, forming the eastern belt, extends from Guilford, one of the most southern towns of the State, to Waterford, and probably as far north as Victory and Burke, where it is cut off by an immense outcrop of granite that extends to Canada line.

The Connecticut River first touches the clay state at Barnet— after which they do not again come in contact till they meet at the bend on the south-east border of Hartford. From Hartford to Bellows Falls, the Connecticut runs upon the edges of the slate much of the distance; hence but little slate is found upon the Vermont side.

In several places between Hartford and Rockingham, flagging and underpinning stones have been quarried from the clay slate, and, in a few cases, slate for grave-stones has been obtained; but generally the strata are much contorted, and abound with interstratified and concretionary masses of quartz; and "cross cuts," or natural joints, are so numerous as to render it valueless for the purposes of roofing slate.

The river, east of Rockingham, is deflected out of its course by the interposition of a bed of gneiss—forming Bellows Falls—and from thence south to Brattleboro runs on a line east of the slate beds much of the distance, thus leaving the slate formation in Westminster, Putney, Dummerston and Brattleboro nearly entire.

At Brattleboro the river again leaves the slate formation and runs a south-easterly course, over a gneissoid rock, into Massachusetts. The slate extends in a line about 15° west of south, from Brattleboro to the towns of Guilford and Vernon. The bed of argillaceous slate just described, insensibly unites with other slate rock of a similar appearance. At Guilford it is bounded on the west by a bed of impure novaculite, which imperceptibly unites with a calcareous mica schist. The same is true at Thetford, but at Waterford no traces of novaculite are found, but the argillaceous is succeeded on the west by the mica slate, having interstratified beds of silicious limestone.

The eastern range of slate, just described, differs from the other slate of Vermont in presenting a more laminated structure. It closely resembles mica schist, and the cleavage corresponds with the laminæ, and varies but a trifle from the planes of stratification. At Guilford we did not observe that any difference existed between the two; but at the Howard Slate Company's quarry, in Thetford, and at the quarry in Waterford, there is a difference of about 8° in the dip of the strata and cleavage. The color of the slate is a dark-gray or bluish-black, and quite uniform, except in cases where the surface is tarnished by the oxyd of iron. The tarnish is confined to weathered specimens, and as the quarries are more deeply penetrated, the slate will be of a more uniform color. In it there are often found, especially in the southern part, very minute garnets or other hard substances, which prevent its being planed and finished into writing slates. For tombstones it answered a good purpose, and was in general use till within thirty years, since which marble has been substituted for it. The average thickness of the deposit is probably not less than a mile, but on borders of the formation the strata are usually much contorted, with occasional veins and concretionary masses of quartz, and not sufficiently fissile to be cleft for roofing purposes. The slate of this belt is very tough, and in many places is in all respects equal to the best slate of Wales.

The greatest width of slate suitable for working in any bed visited on this formation, was found at Waterford, which was twenty-five rods in thickness. This was at the Waterford Slate Company's quarry, situated about four miles easterly from St. Johnsbury. In 1855 there were about forty squares of slate quarried at this place, which were sold and used for roofing, since which time little has been done by the company. The dip of the slate (cleavage) is from 80° to 85° E., and being upon the eastern margin of a hill, with a large and deep valley near at hand to receive the *debris* that may accumulate, the situation must be regarded as unusually favorable.

An exposed face of slate of over one hundred feet in height could easily be had, for by a barometrical measurement we found the ledge was one hundred and sixty-six feet above the valley, less than one-quarter of a mile distant.

A large basaltic dike about eight feet thick is found to extend nearly in a line with the strata, and forms a high wall on the east of the slate bed, and it was doubtless this dike that protected the slate and prevented it from being worn down by drift and other eroding agencies. The durability of the slate is made evident from the appearance of the weathered edges of the strata, which, although exposed to the weather for centuries, now present sharp points that are not easily broken down.

Again, tombstones taken from the weathered rock near the surface of the ledge, fifty years ago, now stand, and are apparently but little affected by exposure. The toughness of the slate is very apparent, for it can be punctured by the point of the slater's hammer without breaking, when held in the hand unsupported by anything else; and this tenacity is the only thing which appears to prevent the successful working of the slate, and, thus far, that is not apparent; but we have fears, that upon penetrating the quarry at greater depths, it may be found too compact to admit of being cleaved for roofing slate.

It is to be hoped that when the value of slate for covering buildings is properly appreciated by the community, that the Waterford quarry will again be worked.

Proceeding south upon this range of clay slate, it is found to be bounded on the east by an indurated talcose slate, most of the distance to Windsor. In Fairlee, one and one-fourth miles west of the railroad, north-east of Fairlee Pond, on land of Amos Waterman, an opening has been made in the range by the Fairlee Slate Co.,—a company incorporated in 1857, with a capital of $50,000. Alexander McLane, of Fairlee, is Agent for the company. The quarry is situated on the western edge of a hill, at an elevation of one hundred feet above the valley. The dip of the slate is from 20° to 35° E. *into* the hill; thus rendering it necessary to remove the overlying rock, or work under it. The quality of the slate is unobjectionable, and the quantity inexhaustible, and were it in an accessible position would be very valuable.

The valuable quarry of the Howard Slate Co., in Thetford, is pleasantly situated in a grove, about forty rods west of the Passumpsic R. R., and one mile north of the village of North Thetford. The strike of the slate is N. 20° E., with a dip of the strata, which are slightly curved, of 76° to 89° E.,—with a cleavage dip, at the same place, of 80° E. The opening now made is in the east side of a steep hill, and the quarry now presents a face nearly perpendicular, eight rods in length, and seventy-five feet high. Like all the slate of the eastern range, this resembles mica slate, and is remarkably tough, except in weathered specimens, and even these are found to be durable when used for roofing; for some surface slate taken from the quarry, and used forty years ago, are now found apparently unimpaired by exposure, and as sound as they were when placed upon the roof.

No quarry in the State is more favorably situated than this; for a deep valley upon the east furnishes ample space for the reception of the waste material, and being at the base of a hill about two hundred feet high, no excavation is necessary, but an unbroken face of slate stands boldly up, as if inviting capitalists to unlock this storehouse of hidden wealth. Occasionally a trace of the sulphuret of iron is seen, but even the weathered specimens are very free from the oxyd of iron; and hence it is reasonable to infer that a roof of this slate will not become tarnished by the decomposed sulphuret of iron, but will continue to maintain the same uniform color.

The Company was chartered in 1855, with a capital of $50,000. Shares $50 each.—A. Howard, Esq., of Thetford, is President, and B. T. Blodgett, Esq., of Bradford, Clerk and Treasurer. About 2500 squares of slate have been manufactured and sold by the company since the quarry was opened. When the wants of the community demand the more universal use of roofing slate, and its value is properly appreciated, the Howard slate quarry, from its favorable position, and the good quality of its slate, will become one of the most valuable in the State.

No other quarries are worked on this range, at present, except those at Guilford—near the southern terminus of the formation. Here two are worked,—one by the New England Slate Co., and the other—the most southern—by the Guilford Slate Co. The quarry worked by the N. E. Slate Co. is the oldest in the State, having been worked since 1812. Slate placed upon a building that year, was taken off twelve years since (in 1847) and put upon another building, and found to be, in every respect, as good as when first laid—which proves conclusively its durability.

Two objections only can be raised against this slate, even by the most fastidious. First, it is often difficult to split them as thin as might be desired, hence the necessity of having a heavy timbered roof to support them; and, secondly, the slate is often tarnished with the oxyd of iron, which gives the roof a checkered and rusty appearance, unless care is taken to select those free from tarnish. Unlike the slate of western Vermont, these can be worked where they have been fractured by frosts and other disturbing agencies; for it was by a slide that occurred in the ledge—doubtless the result of continued freezing that threw the strata over—that the first opening was made in 1812. For several years after its opening, the quarry proved profitable to the proprietors, and about one thousand squares were sold annually; but, like many other efforts in our country to unlock its mineral resources, and bring its stores of wealth into market, this enterprise met with ill success, and became paralyzed in consequence of the importation of slate from foreign countries, which was sold at a price ruinous to those engaged in the business, and paying the prices demanded by laborers in this country.

The quarry worked by the "Guilford Slate Company" is a few rods south of the one above named, and, like the former, is doing but a small business, in consequence of the limited demand for the slate in market. These two quarries probably feel the effect of the importation of the Welch slate more sensibly than other quarries more remote from the seaboard. The dip of the slate in these quarries is about 78° W., and they are well situated for quarrying, having a deep valley immediately upon the west of them.

In the eastern range of slate there are doubtless many other points where good roofing slate could be obtained; and, indeed, there are points where it has been obtained, as at Brattleboro, Bellows Falls, &c.; and when the scarcity of shingle timber compels us to use other material than wood for covering our buildings, and we pursue the true policy of a nation, by patronizing home industry, and using home products, there will be a new impetus given to business in the quarries already opened, and other valuable ones will be brought to light, and made to yield up their stores of hidden wealth.

The Middle Range of roofing slate extends from Memphremagog Lake, in a southerly course as far as Barnard. This slate differs from that in the eastern range, by being more easily split into *thin* sheets, and does not present so much of a laminated structure, and is of a more uniform color, being nearly black, and apparently free from all traces of the oxyd of iron.

The "Northfield Slate Co." have a quarry which is being worked, about one half mile east of the pleasant village of Northfield, where about twenty men are employed in quarrying and manufacturing roofing slate. They were, at the time of our visit, getting out about two hundred squares (that is enough to cover twenty thousand feet of roof) per month. The price of the slate, delivered on board the cars, is $3,75 per square (100 feet.) The quarry has been opened only a short time, and the demand for the slate is not as great as if it had been used for years, and its value fully tested by trial; but such beautiful and valuable slate cannot long remain uncalled for. No observing man who sees them can fail to notice the uniform color and smooth appearance of the roof of the Union School House in Montpelier, the factory buildings in Northfield, and other roofs covered with this slate; and when to these desirable qualities the more important ones of their great strength and durability are known to the community, the demand for these slates must be greatly augmented.

We had hoped to be able to give with certainty the extent of the roofing slate in the middle range, and point out to the owners of the land residing upon it some points favorably situated for quarrying; but the decision to bring the Geological Survey to a close the present season, has prevented us from giving it the attention that it seemed to deserve. From observations made in crossing the State, while engaged in measuring sections, we are fully satisfied of the existence of a wide belt of valuable roofing slate, extending from Memphremagog Lake to Barnard, which we have represented upon the Geological Map.

SLATE PENCILS.

These are quite extensively manufactured in the State—the localities from whence the material is obtained being limited to the clay slate formation of Western Vermont. The slate from which they are made, is a fine-grained greenish slate, where magnesia appears to take the place of silica—rendering the stone soft and easily cut. Slabs of stone are quarried and sawed into strips, from which pieces are cleaved off, of a size suitable to manufacture into pencils. Several parties are engaged in the manufacture of slate pencils in the State, but J. Adams, jr., of Castleton, is probably the most extensively engaged in this enterprise, of any one in the State. Specimens of the pencils, of excellent finish, are upon exhibition in the State Cabinet—presented by Mr. Adams. They are as round as though they had been turned in a lathe, but upon examination it will be seen that they have been forced through a machine lengthwise; and the low price at which they are sold, is evidence that they must have been manufactured by machinery at a very rapid rate.

WESTERN VERMONT SLATE.

The next belt of slate to which attention will be directed, is situated in Western Vermont, and extends through the towns of Castleton, Fairhaven, Poultney, Wells and Pawlet, and passes into the State of New York at Granville. The direction of the strata from the south, is north from 10° to 20° E., having a dip of from 10° to 40° E., In this slate there is a marked difference between the stratification and cleavage planes—the dip of the latter being greater or less than the former. In the "Scotch Hill" quarries of Fairhaven, the strata usually dip about 10° E., while the cleavage is usually 20° E., or more.

The color of the slate in Western Vermont more closely resembles that from Wales, than any other in New England, being of a dark purple, with occasional blotches of green indiscriminately scattered through it. There are also strata in which green is the prevailing color, from which large quantities of slate of a beautiful pea-green color is obtained. In some portions of the formation (as at Granville, N. Y.), slate of a red color is obtained.

The slate of Western Vermont is the most fissile of any in the State, and being remarkably free from silex or other foreign matters, it is exceedingly valuable in cases where it is necessary to have it sawed and planed. At the surface, the slate is soft and worthless, but after penetrating the beds at sufficient depths, it is very compact and sound, and not only valuable for roofing slate, but remarkably well suited for the manufacture of mantels, table-tops, black-boards, &c. Although sixteen years have not elapsed since the first slate of that region was used for roofing, yet it now forms one of the leading industrial pursuits of the vicinity, and bids fair to prove remunerative to those who have embarked in the enterprise of working the quarries.

In 1845, Hon. Alanson Allen, an enterprising citizen of Fairhaven, first commenced working the slate of that region, and for two years limited his business exclusively to the manufacture of school slates. He had machinery and help sufficient to turn out six hundred slates per day. At first the enterprise promised a fair remuneration for the outlay, but in consequence of a rapid decline in the price of school slates in market, the enterprise was abandoned, and in 1847 the first effort at manufacturing roofing slate was made in Fairhaven by Mr. Allen. During that season he manufactured and sold about two hundred squares (enough to cover twenty thousand feet of roof), and in 1849 the amount reached five hundred squares; but the too prevalent custom of people to purchase a *foreign* article in preference to home productions, materially affected his sales, and almost compelled him to abandon the enterprise. But in 1850–51 a new impetus was given to the slate business. Intelligent Welchmen, accustomed to working slate, emigrated to Fairhaven, Castleton and Poultney, and made purchases of land and opened quarries, or were employed by others who had opened them; and such was the character of the slate that the prejudice which had existed against Vermont slate in the cities, disappeared as soon as its valuable properties were fully understood. The result was, that in 1855—eight years after the first effort at manufacturing roofing slate was made—from that vicinity alone there were produced forty-five thousand squares of slate, or nearly twice the whole amount of slate imported from all foreign countries that year. But the ever attendant misfortune that follows the efforts of those in this country, who aim to compete with foreign manufactures, when improved machinery cannot supply the place of manual labor, was encountered by those engaged in the manufacture of roofing slate; for no sooner was the competition fairly established, than the price of roofing slate in market was so materially reduced as to seriously affect those who did not rely upon the cheap labor of Europe, and the result was, that unless the facilities for obtaining the slate and working it were not unusually favorable, it could not be worked to profit, and therefore many quarries were abandoned, and the business declared unprofitable. But men of capital and persevering energy had embarked in the enterprise, and were not disposed to relinquish the work, if by any means it could be made profitable, and if roofing slate would not pay, it was determined to make the experiment of manufacturing it into other articles.

The "West Castleton Railroad & Slate Co." in 1853, commenced sawing and planing slate for black-boards, billiard-beds, &c., and in 1855 the successful experiment of enameling slate was made by this company, under the supervision of E. S. Chapman, Esq., since which the manufacture of enameled mantel-pieces, bracket-shelves, table-tops, &c., has steadily increased, and now thousands of these articles, are annually manufactured and sold by this company. The price at which the mantels are sold, varies from ten to one hundred and twenty-five dollars each, according to the style of finish and amount of work expended upon them; and although they excel in beauty of finish the finest marbles, yet they sell for about one-fourth the price of the marble which they so faithfully

represent. The quarry, manufactories and tenements of this company, are situated in a romantic spot in the north-western part of the town of Castleton, between Lake Bombazine and Glen Lake; and the waters of the latter, at its outlet, afford ample water power to propel the machinery used in sawing and planing the slate.

At the time of our visit (in 1858) there were employed about the works one hundred men, fifteen of whom were engaged at the quarry. From fifteen thousand to sixteen thousand feet of slate were sawed and polished per month, and of this a large proportion was manufactured into chimney-pieces, pier-slabs, table and bureau-tops, mop-boards, bracket-shelves, &c., and marbleized; and in addition to this amount there were also manufactured about one hundred and fifty squares of roofing slate per month.

The company have agencies for the sale of their work, in the cities of Boston, New York, and Philadelphia, and the sales of the second year (1857) amounted to $60,000. The quarry situated near the mills furnished an ample supply of excellent slate, which occurs in large blocks formed by *natural joints* or "sliding seams," thus enabling the quarrymen to obtain blocks of large size for sawing, without the use of gunpowder. The beds of slate forming this quarry do not lie horizontal, but dip to the east at an angle of 50°, while the cleavage dip is only 40° E. The overlying rock is blasted out, and consists of a coarse green (magnesian?) slate, that rests upon a bed of sparry limestone from four to six feet thick. Immediately under the sparry limestone there is a stratum of fine green slate, and under this lies the valuable purple slate, which has a thickness of forty-five feet. At this depth there is a return of the green slate, which extends to the limits of the workable portion of the bed.

In order to secure an inexhaustible supply of slate, the company made a purchase of five hundred acres of land, on which there are numerous outcrops of slate rock; and upon removing the overlying earth, there are found upon the smoothed edges of the slate beds numerous *striæ* and deep grooves, that bear evidence of the existence of an abrading agency, at a remote period of the earth's history, which we refer to the period of the "*drift.*"

We will take occasion here to remark, that green and purple are the prevailing colors of the slate in western Vermont; and they are often so curiously associated as to render it interesting to observe them. In the purple slate green blotches are very common; and in the green slate purple ones are occasionally met with. Again, in the midst of purple slate a stratum of green is often interposed, which not unfrequently terminates abruptly, and is succeeded by the purple. We are not aware that any analysis of the slate has been made sufficiently accurate to determine the material that gives the change of color; but, from examinations made, we are led to infer that the green blotches, and perhaps the green slate, derive their color from the presence of the sulphurets of iron and copper. It is found, upon close examination that, in the central portion of the blotch of green, there is usually a small speck of *pyrites*, and these are found more abundantly disseminated in the green than in the purple varieties. In fact, pyrites are rarely, if ever, found in the purple slate, except in the green blotches; and, from the fact that they decompose readily upon exposure to the atmosphere, all slate containing them should be carefully excluded from those intended for roofing. A roof made of green slate, in which cubes of the sulphuret of iron and copper (pyrites) occur, not only becomes leaky in consequence of the holes left by the decomposed crystals, but it also becomes tarnished with the oxyd of iron (the result of the decomposition of the sulphuret), and presents a rusty and unsightly appearance.

Purple slate is usually regarded better for roofing than the green, but even in the purple there is a marked difference in its value. In some varieties of it, the slate is not sufficiently tough to withstand the effects produced by freezing; in others there are *joints*, which do not show themselves till the slate has been exposed for a while, when it parts and leaves a smooth fracture, and if used upon a roof a leak is quite sure to result from it. In other varieties the color is not permanent, but fades badly upon exposure; and it is reasonable to infer that such slate will not prove durable, and if durable certainly not pleasing to the eye. But there are quarries which produce slate having none of these objectionable characteristics, but the slate is sound, retains its color and is durable. But even the slate that fades, and is not valuable for roofing, may be a source of profit to those who are engaged in manufacturing it into the various articles into which sawed slate enters. Enameled or marbleized slate is not affected by acids, or seriously injured by heat, and its nature seems changed by the heating process to which it is subjected when being marbleized, for it becomes less fissile and much stronger when enameled, than before.

At the outlet of Lake Bombazine the thriving village of Hydeville is situated, and receives its vitalizing elements from the adjacent slate quarries, and the superior water power which is there afforded, having a fall of forty-six feet, and which is employed in driving the saws and machinery of the slate and marble mills of the village. Several companies largely engaged in the slate business are located at this village, and it is from this depot, and the one at Fairhaven, that most of the slate of Western Vermont is shipped.

The "Hydeville Slate Company" have a mill at Hydeville, in which thirty men are constantly employed in the manufacture of tiles, black-boards, fire-frames, &c. About four hundred mantels per month are manufactured, and prepared for marbleizing at their manufactory; but the enamel is applied at a branch establishment in the city of New York. A. W. Hyde, Esq., the energetic and gentlemanly manager of the company, informed us that he had, a few days before our visit to the works, made a contract to furnish twelve thousand dozen lamp bottoms, to a company who were manufacturing kerosene lamps, and wanted marbleized slate bases for them. This company is not engaged in the manufacture of roofing slate, but of articles made from "slab slate" they turn out about $3,000 worth per month. They own a quarry on the western bank of Lake Bombazine, where the strata have a dip of 20° to 40° E. In consequence of the beds being much the thickest on the eastern side, the dip becomes gradually less in the upper beds. In no place have we noticed such a rapid "thining out" of the strata, as in this quarry. The cleavage dip is conformable with that of the strata, a thing of very rare occurrence in the slates of Western Vermont.

In addition to the slate obtained from their own quarry, this company is supplied by the "Western Vermont Slate Co." with one hundred thousand feet of rough or slab-slate annually.

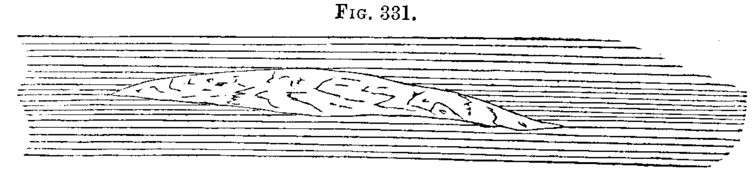
The "Forest Mining Company," of which A. W. Hyde, Esq., is President, also manufacture slate at this place, and give employment to sixty men. They are working five quarries, three of which are on "Scotch Hill" in Fairhaven, and, in addition to $4,000 worth of sawed slate per month, they manufacture and sell about five thousand squares of roofing slate per annum.

The "Eagle Slate Quarry" is situated about one mile south of Hydeville, in the township of Poultney, and the slate raised is used exclusively for roofing slate. The dip of the beds is 20° E., and the cleavage dip is 17° E., with strike N. 10° E. A stationary engine is used to raise the slate and rubbish, and about forty men find constant employment, and reside in commodious dwellings that are owned by the company, and situated near the works. There are annually manufactured from this quarry ten thousand squares of slate, which are sold at $2,50 to $3,50 per square, at the depot at Hydeville. A. K. Rider, Esq., is the superintendent of the works, and seems, in every respect, fully fitted for the varied duties devolving upon him. The slate sold from this quarry is as good as any that can be obtained in western Vermont.

The "Scotch Hill Quarries" are situated in the eastern part of Fairhaven, and north of the village, and were the first worked in western Vermont. The first quarry is situated about one mile north of the village of Fairhaven, and is owned by Messrs. Myers & Utters. The dip of the strata is 10° E., cleavage dip 34° E., with strike N. 15° E. The slate of this quarry is overlaid with a green (magnesian?) slate quite common in western Vermont.

One-fourth mile further north is the "Wilbur Quarry," which has a strike N. 15° E., and a dip of the strata 10° E., while the cleavage dip is 15° E. This quarry is now worked only for *slab* slate—slate to be manufactured into sawed slate. This bed of slate is overlaid with magnesian slate, and sparry silicious limestone. The sparry rock, unlike the green magnesian (?) slate, is not continuous for a great distance, but occurs in interstratified masses of comparatively small extent. An instance of this kind is found near the last named quarry, on land of C. B. Ranney, Esq., where a vein of this sparry rock, about fifteen feet in length and eight inches in thickness, occurs in an outcrop of purple slate, as represented below.

Fig. 331.



In many of the western Vermont quarries this sparry limestone is found interstratified with the slates, and at West Rutland it is also found associated with the marbles.

We regard the sparry rock of Fairhaven the equivalent in age of the "Winooski marble," found in the counties of Chittenden and Franklin. But the variety of color is wanting in the southern portion of the belt, and, being of comparatively limited amount, it will, doubtless, never be successfully used for an ornamental marble.

H. & J. Williams' quarry is situated about one and one-half miles north of Fairhaven village, and is worked for roofing and slab slate. The strike of the rock is N. and S., with stratification dip of 5° E., and a cleavage dip of 12° E. In this quarry there are some indistinct fucoidal (?) impressions upon the weathered specimens of the slate, but not sufficiently well defined to enable the palæontologist to determine their real character.

On a line north from these quarries, on Scotch Hill, are those of Messrs. Hughes & Owen, Benj. Williams, Messrs. A. Allen & Son, A. Briggs, and several in the vicinity of Glen Lake, owned and worked by Messrs. Hughes & Copeland, all having the general characteristics of those before described.

Allen's Capron Quarry is worked by A. Allen & Son, and is situated about one-half mile from Fairhaven village, in the south-east part of the town. The dip of the strata is 10° E., and the cleavage dip is 20° N.E. This quarry has been more extensively worked than any other in Fairhaven, and produces slate of superior quality, and in many respects is unlike any other slate in Vermont. The prevailing color is purple, but there occur in the quarry beds of variegated slate, having a beautifully mottled color of purple and green. It is said that the slate from this quarry do not fade, and as far as my observation has extended they do not.

The "Allen Slate Company," organized under a charter from the Legislature of Vermont, in 1855, made a purchase of this quarry in connection with other real estate, but as yet have not permanently commenced operations. The facilities for obtaining good slate, upon the lands of the Allen Slate Co.—the inexhaustible supply of a superior article—and their proximity to railroad and water communication, render these lands equal to any in the State, and we trust that ere long we may see them successfully worked, by those who are able and willing to provide the appliances of modern improvements and machinery, in which case there is little doubt that the proprietors will be able to compete with, and take precedence of the slate trade from Wales and other foreign ports.

An establishment for sawing and marbleizing slate has recently been started in Fairhaven, by Messrs. Coulman & Hanger, where slate is finished into mantels, coffins, table and bureau-tops, bracket-shelves, &c., in imitation of Egyptian, Spanish, Brocatella, Verd-antique, and other ornamental marbles.

It may not be amiss in this place to give a brief account of the manner in which roofing slate is prepared for market, in the quarries of Western Vermont. A ledge in which there is a great thickness of purple slate is usually selected, and the overburden, consisting of loose earth, impure slate, and all the purple slate that has been split or rendered soft and worthless through the agency of frost and exposure to the atmosphere, is removed, and no slate is used (or should not be) till sufficient depth is attained to produce slate perfectly sound, and from beyond the influence exerted upon it by the atmosphere. This requires a removal of material, consisting mainly of refuse slate, of from ten to forty feet in depth. Blocks of sound slate are raised with powder, or by means of the joints or "sliding seams" in the quarry, and taken to the workmen, who split it—in the vicinity of the quarry—in some place where the waste or refuse slate can easily be disposed of. Care is taken that the blocks do not become thoroughly dried before they are worked, for if they do the slate cannot be split smoothly, if at all; hence, arrangements are generally made to have water drip upon the blocks from the time they are raised from the quarry till they are split and finished by the workmen. It is the business of one man to reduce the large blocks that come from the quarry into smaller ones of such size that they can be conveniently handled by the one whose business it is to "cleave" or split them. The operation of splitting the slate is one that requires much practice and patience, and is generally performed by Welchmen, who take the blocks of slate rock and at a glance perceive the direction of its "cleave" or "rift," and commence work upon it by splitting through the middle of the block, and continue to subdivide each block till sheets of slate thin enough for roofing are produced, when they are thrown into a pile near where the man is seated whose business it is to square and reduce them to proper size for roofing. It is desirable to get out slate of as large a size as can be squared from each piece; and the men accustomed to trimming it will, with their eye and measuring gage, determine and mark, in a twinkling, the size of the square that can be produced from each piece. The length and width of each piece having been determined and marked, the workman places the sheet upon the "trimming bar"—a horizontal piece of steel somewhat resembling a chopping knife—and then with the trimming knife (a thick-bladed knife about fifteen inches long) gives a cutting blow, which is brought slantingly down through the slate, close by the edge of the trimming bar, with which, in effect, it forms a pair of shears, and thus the slate is squared and brought to the requisite size. Piles of various sizes are thus made, which, after being assorted, are taken to the slate yard, ready for market.

To aid such as might wish to order slate, we will here insert the following table, furnished by E. L. Allen, Esq., of Fairhaven, which exhibits the number of slate of the various sizes that are required to cover a *square*, or a surface of one hundred square feet:

6 by 12 takes 533	7 by 14 takes 374	8 by 16 takes 276	9 by 18 takes 213
7 by 12 takes 457	8 by 14 takes 327	9 by 16 takes 246	10 by 18 takes 192
8 by 12 takes 400	9 by 14 takes 291	10 by 16 takes 221	11 by 18 takes 175
9 by 12 takes 355	10 by 14 takes 261	12 by 16 takes 184	12 by 18 takes 160
10 by 20 takes 169	11 by 22 takes 137	12 by 24 takes 114	
11 by 20 takes 154	12 by 22 takes 126	14 by 24 takes 97	
12 by 20 takes 141	14 by 22 takes 108	16 by 24 takes 86	
14 by 20 takes 121			

Three inches are usually allowed for the distance the third course covers the first; or, as slaters term it, "three inches second lap." Thus, if slate is sixteen inches long, the course will be six and one-half inches wide. The average weight of three squares of slate is a ton.

One great obstacle to the general introduction of slate is, that carpenters generally are not prepared to lay slate; and people, especially in the country and small villages, are obliged to send abroad to obtain the services of a slater, whereby so much expense is incurred as to deter many from engaging in the undertaking of putting slate upon their buildings instead of shingles. Now, we would respectfully suggest that as the entire outfit of tools for the slater costs but about six dollars, that it would be well for some mechanic in every village to procure the tools necessary, and make slating a part of his trade. He could then negotiate with slate dealers for what he wanted, receive his commission on the sales that he might make, and furnish his neighbors and patrons with a roof both beautiful and durable.

The slate business in Vermont is comparatively in its infancy. But few openings have been made in the many extended beds of slate that occur in the State, for the reason that there has not been a demand for its universal introduction, as in England and other older countries.

To give some idea of the multifarious uses to which slate is applied, we will quote the words of an Englishman, who, in writing upon slate, says:

"It receives and rigidly retains on its surface the chemical and metallic compounds used in japanning and enameling, by which process it is marbleized, and otherwise ornamented with the most magnificent designs, while its surface presents that of a polished mirror. No stone material as hitherto discovered can be rendered useful in such a variety of ways. It is made to form the floor and trough of pig-sties; the bases that support the columns and the covering of the roof of the capitol; it holds the ink in the desk of the merchant, and forms the liquid manure tank in the farm-yard of the agriculturist; the fermenting and washing vats of the maltster and distiller; the cold liquor and cooling vats of the brewer; the bleaching vats of the dyer and paper-maker, and the hot-bed floors of the horticulturist and florist; it records the first germ of ideality in the school boy. The stall of the fish-monger, the counter-top of the grocer, the shelves of the dairy, the tray of the laundress, the manger of the stable, the cistern that holds our water, and the drain that takes away the sewerage of our cities; the salting troughs of our packers, the condensing chambers of our manufacturing chemists, the floors and sinks of our 'abattoirs,' the heavy crane landings of the dockyards and pavings of our warehouses, the clock faces of our cathedrals, the gravel-path edgings in our ornamental gardens, the vase-pedestal that holds the choice exotics of our conservatories, the bouquet that stands upon the toilet of the boudoir, all admit its presence and confirm its utility. The commissioners of sanitary laws advocate its universal adoption; the trays in which our first infant oblations are made, the tepid bath we use in manhood, the coffin and vault that receives our last mortal remains, and the tablet that perpetuates our memory, alike contribute to its praise."

KAOLIN OR PORCELAIN CLAY.

This clay, which is known by the names of pipe clay, paper clay, and "putty," is found in several places in Vermont associated with the ochres and ores of iron and manganese. When unadulterated it is of a snowy white, quite unctuous to the touch, slightly coherent, and receives a polish under the nail. Unlike most clays this does not change its color upon being burned, and is extensively used in the manufacture of stone-ware, fire-bricks, white earthen ware, paper, vulcanized India rubber, porcelain, &c.

With the pure kaolin there are associated impure varieties, having various shades of red, yellow and brown, containing more or less sand, mica, ochre and other impurities.— These varieties are much less valuable than the white, in consequence of their admixture with the foreign matter; still the dark brown varieties oftentimes are rendered white or light-colored by burning, from which it is evident that the color is not due to the presence of a metallic oxyd, but is a vegetable or carbonaceous stain.

The yellowish variety is most usually colored by ochre which is mixed with it, and when burned is not white, but turns red like the ordinary clay from which bricks are made.

Kaolin occurs in beds in many places, presenting the appearance that would be produced by the decomposition of a feldspathic rock, that once occupied its place; and in other cases it is found stratified or laminated as though it had been transported from its parent bed and afterwards deposited by water.

Fire-bricks have been extensively manufactured from the kaolin found in Bennington, Brandon and Monkton. The brick are not made from pure kaolin, but from kaolin and arenaceous quartz, which are almost invariably found associated with each other. It is found that repeated burnings of the kaolin render it more serviceable in resisting intense heat, than if burned but once, and hence it is taken and moulded into bricks and burned, after which they are pulverized and mixed with quartz sand moulded and burned the second time, with the addition of the pulverized quartz.

Enameled ware, of which the Bennington spittoons and metallic door knobs are examples, are made of kaolin, quartz and feldspar—the color of enamel being given by cobalt and the oxyds of manganese and iron.

The earthen ware known as white granite or iron-stone china, much of which has been made in Bennington (see specimens in State Cabinet), is made of two parts of kaolin and one part each of quartz and feldspar. The feldspar and quartz are both calcined and reduced to an impalpable powder before they are mixed to form the clay of which the ware is made. Porcelain has its translucency imparted to it by mixing calcined bones with the clay of which the ware is made.

White clay is reported to exist in Pownal, and we found large quantities in Bennington, about three-fourths of a mile north-east of the east village, from which was obtained much of the kaolin used in the manufacture of fire-bricks, and at the extensive pottery works of that town. In Shaftsbury, Wallingford, Plymouth, Brandon and Chittenden, beds of kaolin are found associated with the hematite beds, being found above them in every case.

The largest and best deposits of kaolin in the State, are at Brandon and Monkton. At the former place it is not only extensively used in the manufacture of fire-brick, but the Brandon Iron & Car Wheel Co. also prepare and sell large quantities of it, under the name of *paper clay*. It is used in the manufacture of vulcanized India rubber goods, and also in the manufacture of paper, being applied in an impalpable powder to the pulp of which the paper is made. It renders the paper opaque and gives it a good body, at an expense much less than if pure white rags were used alone.

To render the kaolin free from foreign impurities, it is carefully elutriated, after which it is dried and packed, ready for market.

The bed at Brandon has a great thickness — how great is not certainly known — but in the kaolin bed which comes to the surface, is situated the mass of lignite elsewhere described, which has been removed to the depth of eighty feet, and the bottom of the bed of kaolin not reached. But the bed is not composed entirely of the white clay, there being skirtings and occasionally small intercalated beds of variegated kaolin. Some of the varieties are nearly of a blood red, others brown, and other mottled varieties in which are various shades of white, red and yellow.

"It is the opinion of Sir Charles Lyell, who has carefully examined these deposits, that the clay alone will be found eventually to possess a value exceeding that of the iron; and it is not improbable this will be the case, judging from the information which has been obtained from dealers in the article, and from the disposal of a few hundred tons, which have been prepared and sold, and have found a ready market, and have given satisfaction where used in manufacturing."

The kaolin of Monkton, where best developed, appears to be independent of any associated beds of hematite, but the probabilities are, that extensive deposits of iron exist beneath the kaolin, for in no other place in the State is kaolin found independent of the associated beds of iron, manganese, ochre, &c. This bed is in the south part of the town, and about one mile north of the ore bed owned by the "Boston Iron Co."

A bed of kaolin was encountered a few years ago in digging a well a short distance north of the "ridge," of which Mr. Henry Miles, an intelligent gentleman of Monkton, says: "The well, being in a similar geological locality to the kaolin bed belonging to the Boston Iron Company's ore bed, and lying in the same original basin, it is not unreasonable to conclude they are both parts of the same bed, although more than three miles apart." That there is an inexhaustible supply of kaolin in Monkton is not doubted.—In these beds there are the strongest evidences presented of any found in the State, of their production from the decomposed or disintegrated feldspar, as intercalated masses of partially decomposed feldspar are quite abundant in them. Other small deposits of kaolin exist in the State, but those enumerated embrace all the known deposits sufficiently large to be advantageously worked.

CLAY FOR BRICKS.

By a wise provision of Providence, clay beds are scattered over all portions of the State. In the western portion it is the most abundant, and in many places it is too abundant for good roads in wet weather, and too easily caked in dry weather to prove beneficial to the farming interest.

In some of the clays of Western Vermont, there is so much lime associated with the clay as to render it unfit for brick. But where top dressings of clay are made, as is often the case upon light sandy soils, the calcareous clays are found to be the most valuable, and should if possible be selected. They may be known by the effervesence produced when a strong acid is applied to them. Such clays, although valuable for agricultural purposes, should not be used in the manufacture of brick.

It would be useless to attempt an enumeration of all the localities, where good brick clay can be found. As before remarked, it is extensively distributed—there being rarely found a town in the State where clay banks are not found; and although generally of limited extent in the middle and eastern portions, there is evidently in all parts as much as will ever be needed for the manufacture of brick.

PEAT.

Peat, or muck, is a name applied to an accumulation of vegetable matter found in swampy grounds. When first taken from its bed it is a viscid slimy mass, of a brown or dull-black color, composed of fibers of vegetables, amid which there is mixed more or less earthy substances. Upon being dried it has a loose porous texture, loses much of its weight, and will readily burn when brought in contact with flame.

In many parts of Europe, and in some sections of this country, where wood and coal are scarce, it is used for fuel, and known by the name of turf. But in Vermont wood is so abundant at present, that no value is attached to peat beds as sources for fuel. As a

fertilizer, peat, and those accumulations of vegetable matter called muck, must be considered of great value to the State.

In the Report of Rev. S. R. Hall, its value as a fertilizer is fully set forth, hence we refrain from further remarks upon it.

MARL.

This is a term indefinitely applied to accumulations composed of clay, carbonate of lime, silicious sand, shells, &c., that occur in variable proportions, and form a sticky compound when moist, but usually crumble or become light and porous upon being dried.

Where there is a predominance of shells, or fragments of them, it is called shell-marl, and when the mass has much alumina it is known as clay-marl, &c. At times there is such an accumulation of the comminuted fragments of shells and other calcareous matter in such purity, that when burned it furnishes good quicklime. Several kilns are found in the State, where marl is prepared and burned for quicklime, among which may be named the works at Williamstown. The marl is moulded into masses resembling bricks, and dried, after which it is burned. The quicklime produced from it is good, and quite pure, as will be seen by the following analysis of the crude marl, by T. Sterry Hunt. It contains,

Carbonate of lime,	89.0
Carbonate of magnesia,	4.2
Silica with traces of iron and alumina,	1.0
Water and organic matter,	5.5
	99.7

The location of marl-beds is confined to districts where limestone is found, as, for instance, in the vicinity of the impure limestones of the calciferous mica schist of Eastern Vermont, or upon the extensive deposits of calcareous rock in Western Vermont. The presence of lime in the water is deemed essential to the existence of the mollusks that inhabit the shells of which the marl is composed; for without it the shell would not be formed, and the animal could not exist.

It may be urged as an objection to this view of the matter, that water in ponds, having a deposit of marl at their bottoms, are oftentimes very pure. This we admit; but may not the peculiar functions of the mollusks, inhabiting such ponds, contribute to the purity of the water by extracting from it the limy substances contained, and appropriating the same to the formation of the shells in which they are encased? In nearly all ponds having marl bottoms, there are found living species of the shells that compose the marl, consisting principally of the following genera: *Paludina*, *Physa*, *Planorbis*, *Limnæ* and *Cyclas*.

In many places marl is found in marshes, where at present there is no pond, but in all such instances it is evident that one did exist, but by the accumulation of vegetable matter it is filled up. These deposits being most accessible, are of more immediate value than those covered with water, and are the ones usually worked. The beds vary in thickness from a few inches to fifteen or twenty feet. The bed at Williamstown before alluded to, has a thickness of eighteen feet, some portions of which consist of a fine-grained paste, evidently composed of the comminuted fragments of shells that have been accumulating during the untold periods of the past.

When the attempt is made to compute the time required for the formation of the marl-bed at Williamstown, taking into view the fact that it is composed of shells that are rarely one-half inch in diameter, and that the animals inhabiting these are not abundant, the mind at once is sensibly impressed with the impossibility of the undertaking.

Beneath accumulations of marl, there is almost invariably a basin-shaped stratum of clay, impervious to water, in which the water of the pond is held. By digging through the clay, there is often found beneath it gravel, through which the water of the marsh or marl-bed will escape. Hence in situations located upon gravelly deposits, we would suggest that drainage may often be effected in this way. Upon the marl there are usually accumulations of vegetable matter, which, when mixed with the former, makes one of the most valuable fertilizers used by the farmer.

For agricultural purposes, the value of muck and marl is much augmented by being placed in piles, so that the frosts of winter can pulverize them before they are applied to the land.

The localities of marl-beds and value of marl as a fertilizer have been already given by Rev. S. R. Hall (page 725), and we will not repeat them, but merely concur in the statements already made, and add, that we consider the value of muck and marl, properly mixed, pulverized and spread upon light sandy soils, fully equal to the best stable manure.

The intelligent farmer will at once perceive the impracticability of putting muck and marl upon wet ground where there is a superabundance of vegetable mould, or on land strongly charged with lime; but in situations destitute of these fertilizing elements its application will be attended with favorable results.

PAINTS.

Pigments of various kinds are found in different parts of the State, and, in many cases, in such quantity as to be profitably worked. They are mostly confined to the tertiary deposits, and consist mainly of alumina and variable proportions of the oxyds of iron and manganese. Several establishments for the manufacture of yellow and red paints were in successful operation, near the abandoned iron mines in East Bennington, at the time of our visit. It is estimated that six hundred tons of paints were prepared and sent to market from this State during the year 1857.

The material for these paints from Bennington is obtained from "knobs" or swells of land near the base of the Green Mountains, and in the valley of Roaring Branch, in Woodford. The beds of ochre are opened, and the material suitable for paint is taken from thence and conveyed in wheelbarrows to sluices somewhat resembling those used for washing gold from auriferous gravel. But there is this difference in the two operations: in the latter the worthless material washes off down the sluice and the precious metal lodges upon the bottom; but in this case the worthless material, in the form of pebbles, iron ore, sand, &c., settles at the bottom, and the substance valuable for paint is taken up by the water and carried along down the sluice. Spouts conduct this water, holding the paint in suspension, for considerable distance into large vats, where it is suffered to remain and the paint to settle at the bottom. The water is then decanted, and the sediment at the bottom of the vats allowed to dry till it assumes the consistency of thick mud or clay, when it is cut into pieces about the size of bricks, and laid upon shelves to dry in buildings prepared for the purpose. When perfectly dry it is run through a mill and packed in barrels for market. This is yellow paint, and very similar to the paints called French, or spruce-yellow, so much used for painting floors in Vermont.

Red paint is also manufactured in large quantities at these establishments. This is done by taking the dried lumps of yellow paint and putting them into large ovens and calcining them. By this process more oxygen is acquired by the ochre through the agency of heat; and the result is that red paint is produced closely resembling the variety called Venetian-red.

BRANDON PAINTS.

Paints are extensively manufactured in Brandon by the "Brandon Iron and Car Wheel Company;" and in this town there is found a greater variety of material suitable for pigments than in any other in the State, and probably greater than at any other place in New England.

By the following list and description, taken from a Circular of the Company, it will be seen that several colored paints are produced; and we will here remark that the testimony of those who have used them fully sustains the assertions made respecting their value and durability:

"*Brandon Yellow.* This paint has more body than any other yellow, and makes a hard and durable paint for floors, outside work, &c.

"*Brandon Brown*—has the best body of any mineral paint known, takes less oil than other paints, and is, therefore, the cheapest paint in use.

"*Brandon Red.* This paint, when mixed with oil, forms one of the most adhesive coverings that has yet been discovered for painting on wood, iron, or tin, and is a better protection to them than red lead, as it adheres better.

"*Brandon Roofing Paint.* This paint can be mixed with raw oil, without grinding, and forms a very hard and excellent fire-proof covering, particularly adapted for roofs of houses and cars, decks of steamboats, &c., &c.

"*Brandon Umber* (raw and burnt.) This pigment, used alone as a drier in boiling oil, in the usual way, one-fourth pound to the gallon, is one of the best drying substances known; and, after being used in boiling oil, can also be used as a paint, without loss, as the heating does not harden it. It is slightly darker in shade than Turkey umber, but is much purer than the common article of commerce; and in light tints, in white lead or zinc, it makes a much handsomer color than the best Turkey umber. It is ground fine, and put up in packages of various sizes, from twenty-five to three hundred pounds.

"The Brandon paints having been thoroughly tested and approved, the company have entered largely into their manufacture, and present them to the public with great confidence as the best paints in the market.

"These paints are composed of alumina, protoxyd and peroxyd of iron, and deutoxyd of manganese, in variable proportions, constituting the varieties offered for sale. They form with oil not a simple mixture, but a chemical union not easily decomposed, and hence their durability when exposed to the action of the atmosphere, or of water. They differ from the ochres by being in part constituted of deutoxyd of manganese, which forms with oil one of the strongest and most adhesive compounds of oil and the metallic oxyds.

"All the constituent parts of these paints unite and form a chemical union and definite compound with oil, and differ widely, in this respect, from paints of which silica is a basis, which ingredient has no affinity for, and forms no combination with, oil.

"The Brandon paints possess, in an eminent degree, all the qualities requisite for the protection of wood and iron, and experience proves their superiority on iron, tin, brick, wood, cloths, &c., and they are excellent substitutes for red lead or brown zinc, to which they are far superior, either above or under water. They are ground fine, have good body, cover well, and are more durable and much cheaper than white lead or any paint having white lead or zinc for a basis.

"The colors are permanent and unfading, and are particularly adapted for outside work, railroad and other bridges, ships, decks of steamers, cars, carriages, fences, roofs, &c. Muslin, when painted with two coats of Brandon paint, makes a light and water-proof covering, much superior to the heavy tarpaulin so much used.

"The paint has been extensively used in and about gas holders, to the entire satisfaction of gas companies; and machinists, carriage, omnibus, and car-builders, give it a preference on account of its heavy body, which, being well adapted for rubbing down, gives a beautiful and enduring enameled surface. It adheres firmly to iron, and is the best paint in use for the protection of that metal.

"The red and yellow, mixed together, make the best STAIN known, and are highly prized for that purpose by cabinet and sash makers. The colors are well adapted for station houses, cottages, cars, bridges, and are particularly deserving the attention of railroad companies, as also of builders, and both house and ship painters, painted carpet manufacturers, and dealers in paints, &c.

"The dry paints require only to be mixed with oil, without grinding, for use. The roofing paint is used with raw oil, and is the best article known for painting tin, roofs of cars, sheds, houses, &c., and is also a great protection against *fire*.

"They contain none of the poisonous qualities of white lead, and their use is not attended with any of the fatal consequences attendant upon the use of that article. A given quantity will cover a very much larger surface than either lead or zinc.

"Owing to the superior facilities possessed by the company, in the manufacture of these paints, they are enabled to furnish them at as low rates as other and inferior paints are sold.

"These paints have been extensively used on the light-house buildings on the New England coast, by order of the U. S. Government, and by the principal railroad and machine shops, &c. &c., and have in all cases given entire satisfaction.

"Persons desirous of making trial of these paints, will be furnished with samples for that purpose, upon application at the Company's offices."

Much of the material now used for the manufacture of the red and yellow paints, is obtained by washing the iron ore preparatory to its being smelted. It is necessary to wash the hematite that is found imbedded in a matrix of ochre, before it is smelted; but we think the company at Brandon is the first and only one in the State that saves the material washed off, for paint. From the washing machine the liquor is conducted to vats, and subjected to processes similar to those already described at the Bennington paint works.

In addition to the oxyds of iron, there are other pigments found in Brandon, among which is *umber*, a rare mineral paint, composed principally of the oxyds of iron and manganese, and very valuable as a *drier*. Most of the umber in market has heretofore been obtained at the Island of Cyprus. The annual sales of Brandon paints amount to about twelve hundred barrels. A short time before our visit to the works, they filled an order for two hundred and forty barrels, which was sent to England—forty of which was umber.

Numerous other "paint beds" are found in the State, but the foregoing embraces a notice of the places where paint is prepared for market. There is probably not a bed of hematite in Vermont that would not furnish material for red and yellow paints, and probably there may be other beds of umber in the vicinity of those iron beds where manganese enters largely into the composition of the ore—or where, like the locality at Brandon, the manganese is found in isolated beds, independent of the iron ore. Ochre beds often exist where workable ore is not found.

CURTIS' PAINT.

On a hill, a few rods east of North Dorset village, there is a substance which has been called "a remarkable vein of iron ore, that has become mostly disintegrated and converted into ochre." This vein has been penetrated horizontally one hundred and fifty feet, and perpendicularly one hundred feet, without any perceptible difference in its character for that distance.

This vein, which has a uniform thickness of about three feet, and stands perpendicular between walls of a calcareous quartz rock, has the appearance of a porphyritic dike; hence we were disposed to call it a dike of "plastic porphyry," or lithomarge. It has various shades of red, yellow, gray, and white, that are irregularly blended together—in some places producing a reddish-chocolate color, and in others distinct crystalline grains of white occur in a reddish or yellowish ground, having the exact appearance of porphyry. It has a fine texture, soft and rather unctuous to the touch, and can be cut and polished with a knife, without injuring its edge. In this dike there are found concretionary masses that cannot be easily cut, but are very solid, and closely resemble cinnabar in texture and in color.

The substance forming this dike is dug out and sold in its crude state by the proprietor, Daniel Curtis, Esq., to parties in New York who grind and sell it for paint. We cannot, from personal observation, attest to its durability, but were told that it proved durable upon long exposure. We think it might be valuable to manufacturers of vulcanized India rubber, or in the manufacture of earthen and stone ware, if used in the place of kaolin.

In several places in the State, we have found a reddish substance, which we were inclined to call red kaolin, but which we suspect may have been identical with the substance forming the Curtis "paint dike."

In Dorset, not far from the residence of Hon. L. B. Armstrong, we found a reddish substance, that in places entered into the composition of the limestone, and in others was quite pure, having no grit, and being quite friable. We suspect this may have had an origin and character like that found at North Dorset.

In the marble quarry of Messrs. Holley, Fields & Kent, on Mount Eolus, we found in the cavities existing there a substance very similar to that under consideration, which we now think was the remnant of a small dike composed of this soft substance, but which is now mostly washed away. Contiguous to this red substance in the quarry, and along the joints in which it is found, the marble is considerably stained with a reddish coloring matter—in some cases to the thickness of five or six inches. Had this substance been deposited during the tertiary period, why would it have communicated the red stain to the hard marble? Is it not more plausible to suppose that a dike filled the fissure in the semi-plastic marble, and communicated the stain at that time? And since that time, owing to the unresisting nature of this soft dike, has it not been weathered out, with only fragments left to attest its former existence?

In Waitsfield, about one mile north-east of the village, on land of Joseph Hesselton, we were shown an "ochre bed" by Daniel Richardson, Esq., which we think may have been an outcrop or remnant of a mass of lithomarge, similar to that of North Dorset.

Since the foregoing was written, we learn from Mr. Curtis, of North Dorset, that he has found another paint dike a few rods east of the one before described. It is of about the same size and character as the first one which he opened, and the two run through the rock nearly parallel to each other. They are both nearly perpendicular, and run N. 25° E. The limestone that incases these dikes has in it numerous joints that seem parallel to the dikes, which circumstance renders plausible the supposition that they are intrusive masses, and not sedimentary deposits.

MANGANESE.

This metal in its pure state is fine-grained, hard and brittle, and of a grayish-white color like cast iron. It has great affinity for oxygen, and is never found in beds except when combined with it. Of the ores of manganese there are many varieties, of which the following are the most common:

The Deutoxyd or *Pyrolusite;* the Sesqui-oxyd, in combination with a base, or *Psilomelane;* the Sesqui-oxyd or *Braunite;* the hydroxyd or *Manganite;* the Sulphuret or *Manganblend;* the Carbonate or *Diallogite;* and the Earthy Oxyd or *Wad.*

Pyrolusite, one of the most valuable varieties of manganese ore, is of a bluish-gray color with a metallic luster, and a granular or subcrystalline structure, with occasional incrustations of minute steel-gray crystals lining cavities or traversing open fissures. It is usually associated with beds of brown hematite, or with other ores of manganese.

Psilomelane, which is found associated with the above, occurs in smooth, black, botryoidal or mammillary masses, which, upon a fresh fracture, present a compact structure resembling that of hard iron or steel. A specimen from Brandon, analyzed by Prof. Olmsted, gave the following results:*

* See Prof. Adams' Second Geological Report, p. 225.

Red oxyd of manganese,	81.38
Oxygen,	2.74
Manganese,	2.22
Silica,	3.60
Water,	9.75
	99.69

It therefore contained, if there be no error,

Metallic manganese,	58.755
Oxygen,	25.366

which scarcely differs from the constitution of sesqui-oxyd of manganese.

Braunite is another variety of manganese, not as abundant in Vermont as the two preceding varieties, but has been found in small quantities in Plymouth, Brandon, Chittenden and Bennington. It has a dark-brown color, and a vitreous luster, occurring usually in geodic or botryoidal masses, implanted in the other ores of manganese.

Of the numerous ores of manganese, the foregoing three are the most abundant in the State, and are the ones considered the most valuable in the arts. The first two are found at Brandon, Bennington, Bristol, Chittenden, Colchester, Plymouth, Pittsford, Stamford, Wallingford, and probably at other places, associated with brown hematite.

The oxyds of manganese are extensively used in the manufacture of the chloride of lime or *bleaching powder*, so valuable as a disinfectant, and so indispensable to the paper manufacturer. In calico printing, the oxyd of maganese is an important auxiliary, and its use is indispensable in many instances.

Psilomelane, and the other oxyds of manganese that are free from the oxyds of iron, are used by the glass-maker to give a transparency to the glass, that otherwise would have a greenish color, occasioned by the iron contained in the sand used in its manufacture. When there is an excess of manganese used, the glass has an amethystine or violet color, hence it enters into the composition of glass used for ornamental purposes.

The oxyds of manganese and iron are used to give the unique and clouded appearance to enameled stone ware. The pure oxyd of manganese, when used, imparts to the enamel a leaden-black color; but when the two oxyds are mixed together and sprinkled upon the moist glazing, and suitably calcined and united with the enamel, they produce the shaded colors seen upon the spittoons and other enameled ware so extensively manufactured and sent abroad from the manufactories in Bennington. Blocks of iron ore, rendered worthless for smelting in consequence of the amount of manganese united with the iron, and strewed upon the ground in the vicinity of the abandoned iron mines of that town, have been collected and used by the stone ware manufacturers, and found more valuable for a coloring substance than any artificial mixture of the two oxyds they have been able to make. In the vicinity of most of the beds of hematite in the State may be found masses of the impure ore, should any be wanted.

For most uses, the pure oxyd of manganese is the most valuable, and in some cases it is indispensably necessary that it should be free from iron or other foreign impurities. Beds of the oxyd of manganese, unconnected with the iron ore, are found in Brandon and Chittenden, and the article has been found remarkably pure; orders have been received for it from England, and large shipments of it made. We find, in Prof. Adams' Third Geol. Report (p. 29), that

"A locality of the silicate and black oxyd of manganese occurs in the north-west part of Irasburgh, one mile west of Coventry village. No opening has been made, and no estimate of the extent can be given. The fact that many fragments have been found as far south as Craftsbury, precisely similar, furnishes the best evidence of an extensive vein."

Manganese Wad, or the earthy oxyd, is found in the State, and is oftentimes considered, by those unacquainted with its true character, the harbinger of something valuable. It usually occurs not far below the surface of the ground, occupying positions similar to that of bog ore, and is not unfrequently associated with it. It is found in thin beds composed of a black substance, slightly coherent, or of an aggregate of small nodules, that readily become separated and fall to pieces upon exposure to the sun. It is seldom found in large quantity, and is of little or no value in the arts.

COAL.

The question of the existence of coal is one that would naturally present itself to the minds of those interested in Vermont Geology. In the scientific department of this Report the questions respecting the age of the rocks in the State have been fully discussed, and, as far as characteristic fossils have been found, the age and equivalency of Vermont rocks have been determined. But over a large area, including all the metamorphic schists, no fossils have been found to disclose the date of the geological period to which they belong. So far, therefore, as these undetermined rocks are concerned, we cannot speak with certainty, and are not prepared to say positively that no coal exists in the State. But in some portions, and of those too where many excavations have been made for coal, we can speak positively, and unhesitatingly declare that no workable beds are to be found.

It may not be amiss to say that fossils — the polar star of the geologist — determine the comparative age of the palæozoic rocks, and clearly demonstrate to the intelligent palæontologist that there is a regular sequence extending from the date of the earliest organisms up to the time that man appeared upon the earth. A progressive development is observed in the structure of these relics of the past, and so marked is the distinction that no practiced eye would mistake a fossil of recent date for those of earlier types.

It has been the work of master minds to study these vestiges of created organisms, and determine their place in the rock formations; and as a result of such investigations, it is found that "the Author of nature, though always working upon the same plan, and producing an infinite variety of forms almost incomprehensible to us, has never repeated the same forms in successive creations. The various organisms called into existence, have performed their parts in the economy of creation; have lived their period and perished. This we find to be as true among the simple and less conspicuous forms of the palæozoic series, as in the more remarkable fauna of later periods. The truth of all these conclusions is now so well established by the results of scientific investigations that we regard the history of the past, from the dawning of vitality till man assumed the dominion

over the whole, as marked in certain and intelligible characters incapable of misinterpretation."*

Thus it is seen that each geological cycle had its own peculiar fauna and flora, representatives of which are found in each succeeding rock formation. Characteristic fossils of one type are found in the Silurian rocks, while those essentially different exist in the coal measures.

Now with the numerous fossils found, as guides, and with the conclusions of geologists, sustained by evidence presented in careful investigations that have extended over the civilized portion of the world, that coal is of vegetable origin, and its occurrence in workable quantity is restricted to certain rocks of comparatively recent origin, it must be apparent that there is not a probability of its existence in any of the fossiliferous rocks of Vermont.

The rocks of Vermont, whose ages are determined by their imbedded fossils, are of Silurian and Devonian age — too old to contain workable beds of coal — and were deposited long before the earth was in a condition to sustain the luxuriant growth of vegetation requisite for the production of the immense carboniferous deposits existing in the coal measures. But persons unacquainted with geology, and perhaps regarding the occurrence of coal as accidental, and governed by no fixed laws, have vainly sought for it among the Silurian rocks of the Champlain valley, confiding more in the evidence exhibited upon the glazed surface of the black slate than in the well settled facts of science. Disappointment must follow all such unwise adventures.

Should coal exist in the State (a supposition hardly probable), it will be found in Eastern Vermont; and being in the metamorphic rocks, it will be of the variety denominated anthracite.

BROWN COAL.

From the preceding remarks it may be inferred that nothing analogous to coal exists in the State. But such is not the case. Carbonaceous matter capable of sustaining combustion and emitting heat, is found in the tertiary deposits of Western Vermont.

Brown coal, embracing lignite, is found quite abundantly at Brandon, and, we doubt not, may exist in other places associated with the white clays that overlie the beds of hematite. It is not found in beds, but in upright masses that extend down and cut obliquely through beds of kaolin. There are two localities of it in Brandon, about sixty rods apart. The larger of these masses, situated contiguous to the ore bed of the "Brandon Iron and Car Wheel Company," having an area about twenty-five feet square, has been penetrated to a depth of eighty feet perpendicular, and the coal removed and used as fuel for driving the engine to drain the mine and raise the ore.

This coal is of a dark-brown color, and is apparently composed of drift-wood and other vegetable matter that have been promiscuously thrown together at a period comparatively not very remote. The woody texture is plainly to be seen in many of the specimens, and the outlines of many fragments of trees are often well defined. Fruits of various kinds (described elsewhere in this Report) are quite common in the larger bed; but in the smaller one no traces of them are to be found. Another noticeable fact in this connection is, that the fruits are found to be different at different depths of the bed.

* Prof. James Hall.

The lignite, upon exposure, turns to a darker color and becomes harder, and resembles more closely bituminous coal than when first taken from the mine. It readily burns with a yellow flame, emitting no sulphurous or bituminous odor, and produces about the same amount of ashes that is obtained from wood.

The position of the lignite, and its relation to the associated minerals, may be seen in Fig. 332, the lignite being at the point marked L.

From an analysis by John H. Blake, Esq., of Boston, one of the proprietors of the ore bed, the brown coal is found to contain

Volatile matter,	4.50
Carbon,	93.50
Ash,	2.00
	100.00

Not a trace of sulphur is to be found in any of it. In some of the specimens small angular fragments of quartz are quite abundant; but the above analysis was not determined from specimens containing that impurity.

Beds of vegetable matter, more recent than the brown cool of Brandon, are found in Burlington. They occur beneath the surface at variable depths, in some cases being forty feet deep. Occasionally only the body of a single tree* is found, but more usually beds of considerable extent exist, composed of exogenous trees, grape vines, grasses, moss, &c.

These beds rest upon clay, which appears to have formed a basin in which vegetable matter accumulated. Alternations of clay and gravel are very common in the strata at Burlington, and land-slides occasionally occur. Notwithstanding the situation of Burlington upon a succession of terraces, there were, in the early settlement of the place, many deep marshes of limited extent, which have since been drained or filled up. From Hon. Levi Underwood we learn that one of these existed not far from where the Town Hall now stands, but was filled up. Should excavations at some future time be made at that place, there is little doubt that a bed of fossil wood, or lignite, would be encountered, and, in all probability, live frogs would be found imbedded in the earth far below the surface, in what once constituted the muddy bottom of their pond.

IRON.

Iron, which contributes more to supply the varied wants of man, and is made more serviceable than any other metal, is found abundantly disseminated in the crust of the earth and in a greater variety of combinations than any other metal. Ores of iron are scattered with beneficent profusion over every portion of the earth, and it not only forms an essential ingredient in most of those substances that are compounded in the great laboratory of nature, but it enters into the material organization of man, and is essential to his existence.

Iron readily unites with oxygen, and when exposed in damp situations becomes coated with the oxyd of iron — or rust. It occurs in nature in the form of oxyds, and is found in combination with sulphur, carbon, arsenic, &c. These compounds are called *ores*.

*For more particular description see pp. 134—139 of this Report.

Many ores of iron are found in Vermont, among which are the brown oxyd (Limonite or Hematite), the earthy oxyd (Bog Ore), red oxyd (Red Hematite), black oxyd (Loadstone), and the specular and micaceous oxyd; also the sulphuret of iron (Pyrites), arseniate of iron (Mispickel), titanite of iron (Ilmenite), carbonate of iron (Spathic Ore), and *chromate* of iron.

Of these, in Vermont, the brown oxyd or hematite is the most abundant and valuable for smelting. It occurs in amorphous, globular, reniform and stalactical masses that possess every shade of color from a light-yellow, to a dark reddish-brown. Concretionary specimens usually present upon the fractured edges a fibrous or splintery structure, and have a metallic luster. These masses are generally imbedded in, and have upon their surface a friable oxyd of iron known as yellow ochre, from which the solid and valuable ore is separated by washing before it is smelted.

The brown oxyd of iron is not found imbedded in the rocks of Vermont, but reposes on them, and immediately below the drift deposit. Associated with the iron are beds of kaolin, oxyd of manganese and yellow ochre; and with the beds in Brandon, there is a deposit of brown coal, all of which belong to the same formation,— probably the Miocene or recent Tertiary. The best development of this is found near the western base of the Green Mountains, where the beds rest upon a silicious limestone, next west of the quartz rock. In this limestone iron ore (the carbonate, sulphuret and specular) is found disseminated, but not in such quantities or quality as to warrant the working of it; and from this source was doubtless derived all the iron forming the beds reposing on it.

Quite an extensive deposit is found in Plymouth, upon the eastern side of the Green Mountains. Ochre and kaolin beds abound in connection with the iron ore, and a ferruginous limestone is found beneath and contiguous to these beds, being in all respects similar to that found upon the western side of the mountains. The quartz rock is found upon the eastern side of the beds that lie west of the mountains, and upon the west side of those lying on the eastern side. This fact—coupled with the one that these recent deposits rest upon rocks on both sides of the mountains, that are in all respects similar,—gives plausibility to the inference advanced on page 37 of this Report, that an extensive plication of strata exists, and forms a "great anticlinal fold." The development of quartz rock on the eastern, is not as extensive as upon the western side of the fold, still we can but regard the extended ledges of quartz rock in Plymouth as counterparts of the quartz rock found in Western Vermont at the base of, or forming mural escarpments upon the western side of the Green Mountains.

BOG ORE.

Bog iron ore, or the earthy oxyd of iron, is of common occurrence in Vermont; yet there are no large deposits of it, and probably but very few, if any, places where it occurs in sufficient quantity and of a quality that would prove remunerative, should any one attempt to work it. It is usually found in *bogs*, or marshy spots that have received, or are receiving, the washings from adjacent ledges that contain, or have contained, disseminated particles of some ore of iron.

The exudation of water (chalybeate water) depositing the oxyd of iron from crevices of rocks, or from the land upon hill-sides, has awakened the curiosity of many individuals, and led them to suspect that extensive deposits of valuable ore existed in the hill, or near the source of such springs. But such conjectures are not generally well founded. The sulphuret and carbonate of iron, which are very abundantly disseminated in the rocks of Vermont,—but which are of no value for smelting,—upon exposure to moisture and the atmosphere, readily become decomposed, and there is formed an oxyd of iron which gives a yellowish tarnish to the face of the rock, or, when suspended in water that is suffered to stand long undisturbed, settles to the bottom in the form of a sedimentary yellow ochre.

A scum of "iron rust" is not unfrequently seen in pools of stagnant water, which, by many, is regarded as a sure indication of the existence of good iron ore in the vicinity. But such is not the fact in a majority of cases.

The deposits of ochre in small quantities, and the ferruginous stains upon the ledges of rock, generally result from the decomposition of the sulphuret or carbonate of iron. A good illustration of this is seen near the copperas works of Strafford. Beds of bog ore reposed upon, and were found a short distance below, the outcrops of the sulphuret of iron found there, that were evidently derived from the pyrites, before any effort was made to work the bed for copperas ore, but they were limited to spots quite near the formation from whence they were derived. The stones in the brook near the works, and from thence several miles down the stream, are now coated with the oxyd of iron; and in the stagnant pools, and basins, where the water permits the accumulation of sediment, there are considerable deposits of bog iron ore. Now these latter beds can be traced to their origin, for prior to 1809, the year the first copperas was made in Strafford, the rocks in the brook were not discolored by ochre, nor did beds of bog ore exist. But in the manufacture of copperas, there is always a sediment—the peroxyd of iron*—and the escape of this has given the yellow color to the rocks in the brook, and formed the deposit of bog ore in places where the tranquil water suffered it to settle.

If, then, it is proved that beds of bog ore are now forming, and have attained considerable size during the last fifty years, and that the material forming them was derived from an ore of iron (the sulphuret) perfectly worthless for smelting, and even injurious when used with other ores, how futile would be the attempts to trace oozings of ochery water to their source, and blast out rock, with the expectation of finding workable ore therein!

So many cases have come under our observation where explorations have been made, or were contemplated, for ore in situations where it was not likely to exist, that we cannot well refrain from extending our remarks upon this subject, and show the impracticability of digging for iron ore in places where there are no better indications of its existence than the "iron rust" that accumulates upon the standing water, or is seen upon rocks in the vicinity of the supposed mine.

Basaltic and hornblendic dikes are not unfrequently supposed, by those unacquainted with their nature, to be veins of ore. Many a mile have we traveled with intelligent men to see a dike that was supposed by them to be ore. In one case where we hesitated

*This sediment is at some manufactories of copperas calcined, and sold for a red paint. It is also used extensively by cutlers and silversmiths for polishing, and is called "crocus," *rouge* or plate powder. When reduced to an impalpable powder and mixed with hog's lard, it makes an excellent *paste* for razor strops.

about going to see an "ore vein," we were assured by the owner of the land that the "ore" had been tested and found to be remarkably rich, and produced iron of so superior a quality that Judge T***** of B**** had offered him forty dollars a ton for all the iron that could be obtained from this superior ore vein. Upon reaching this "vein" we found it to be a concretionary trap dike, about three feet wide, from which considerable "ore" had been blasted, and was piled up ready for shipment. The offer made for the iron that could be obtained from *that* ore, was a safe one, for in a furnace not a pound of iron could be extracted from a ton of it. In it there was a sufficient amount of iron to give the surface of the rock a rusty appearance, but not enough to be of the least value for smelting. This is one of many similar cases, where dikes have been blasted into for iron, silver, lead, tin, &c. Dikes are well calculated to arrest the attention, and deceive those not acquainted with them. They are intrusive veins of matter—in composition and appearance wholly unlike the rocks in which they are found, and very often have a semi-metallic appearance, with a rusty coating upon the surface. But dikes are of nearly uniform width for considerable distance, and occur between parallel walls of rock, with limits well defined, which is rarely ever the case with iron ore beds or veins, which generally have an irregular outline not well defined.

That noted personage the "old Indian," a myth that in days of yore visited so many lead and silver mines in the State, has also learned the location of several iron mines and confidentially imparted the fact to some pale-faced friend, but unfortunately the rocks or trees that marked the spots are generally removed so that the precise location is not now known. Numerous excavations, in different parts of the State, mark the spots where fruitless efforts to reach such hidden treasure have been made by digging and blasting.

The variation of the magnetic needle is regarded as a certain indication of the existence of beds of iron ore. But this is not a sure criterion, for we have witnessed a variation of ten degrees in the distance of ten rods, where we are confident no workable ore existed. In the vicinity of serpentine ledges, the needle is almost invariably affected by local attraction; but in a majority of cases no iron of value is to be found in the vicinity. We have several times found isolated blocks of dark-colored serpentine, that would influence the needle when brought near them.

The occurrence of disseminated crystals of iron in chlorite and other rock, gives rise to the belief that beds of ore exist beneath or in the vicinity of them. With due deference to the judgment of those who think otherwise, we must dissent from this opinion. We know of no cases where octahedral crystals of iron are found skirting beds of ore, and in all cases where trials have been made to reach such beds, the efforts have proved unsuccessful.

On a hill of serpentine about two miles east of the village of Rochester, on land of Mr. Morgan, there is imbedded a mass of chlorite, in which crystals of octahedral iron are quite abundant. From this circumstance, it was inferred that a quantity of valuable ore existed in the hill beneath the outcrop of chlorite. Measures were adopted to test the question, and the work was perseveringly prosecuted by driving in an adit from the side of the hill, about one hundred feet to the spot where the bed was supposed to be located. But the non-appearance of ore, disappointment and loss were the legitimate results of the enterprise.

An exploration for ore made under similar circumstances in Bethel, some years since, where an adit was driven in about one hundred and eighty feet, resulted in the death of one of the miners by the premature discharge of a blast, but no ore was reached, and the work was abandoned.

Much money has been expended in the vain search of workable ore in the drift formation. It not unfrequently happens that detached masses of brown iron ore (hematite) and yellow ochre, are scattered promiscuously in the drift, and from this circumstance it is inferred that workable beds of ore exist near such localities. This is not always the case: but in localities that were sheltered upon the north or north-west, from those powerful currents that existed during the drift period, the occurrence of ore and ochre are favorable indications, and when found in the immediate vicinity of ferruginous limestone, the evidence is decidedly in favor of the existence of workable beds of ore. But if found upon a different rock where no barrier exists, but in a comparatively open plain—where the potent agencies that were exerted during the drift period would be likely to sweep out the unprotected beds, and subsequently deposit in their stead, rocks, gravel and fragments of ore from more northern localities—the prospects for finding good beds of ore are not flattering.

Much money has been expended in Plymouth and Ludlow—by driving drifts into terraces where fragments of ore and ochre existed, under circumstances like those just enumerated—in the vain search for a bed of ore. In other portions of the State the same is doubtless true, but the instances have not come so directly under our observation.

These fragments of ore in the soil are oftentimes significant, and point out the location of beds or veins that are valuable. If the masses of ore are not water-worn and rounded by attrition, but present sharp angles upon the surface, a reasonable inference is that beds of the same material exist at no great distance north of the spot where they are found.—If, for example, detached fragments of hematite were found in the soil upon the western side of the Green Mountains, and near their western base, the most reasonable conclusion would be that they were the remnants of a bed of ore that had been partly removed from its original position, or that the remaining portion of the bed from which these fragments came, existed in some recess to the north of the place where they were found, and between spurs of rock that opened to the south or south-west.

The manufacture of iron under favorable circumstances, and when judiciously managed, has generally proved very profitable to the proprietors, but we give it as our opinion that more money has been injudiciously applied and needlessly expended in excavating for ore in Vermont where it did not exist—and in a majority of cases where the indications were not such as should favor the reasonable belief of its existence—than all the net profits ever realized from the manufacture of iron in the State.

With these convictions, the labor of the geologist should not be wholly to point out and encourage capitalists to make investments for working untried and undeveloped beds of iron ore, but rather to dissuade all persons from entering a field and rushing blindly on, in paths which experience has proved so calamitous to those who have before pursued them.

A knowledge of rock formations, their nature, and the relations they sustain to each other, seems indispensable to the success of those who would engage in quarrying and mining enterprises.

Cases occur where shrewd business men, with acute perception and good common sense, succeed in whatever business they engage; and there are cases where such men succeed in working quarries and exploring mines, but instances are about as rare as it is to find a man who can succeed in any other business where he "goes it blind."

A person to work successfully should work understandingly in any business. One case illustrating this point is given in Prof. Adams' Second Geol. Report, p. 215. In speaking of the iron ore of Bennington he introduces an extract from a letter of Prof. Dewey, who had visited the furnaces and ore beds under consideration. After speaking of the occurrence of beds of manganese, the Professor says he was informed by the one who worked the furnace, that, "On finding that black pure manganese, he put a large quantity into the furnace, to get better iron from this purer [iron] ore as he thought it; that when they tapped the furnace the liquid stream took fire and burned with fury in all directions, driving all the hands from the building, so that it was not possible to proceed till the manganese was removed from the furnace, at no little expense." The manager evidently mistook the manganese for iron ore, and, instead of the rich flow of iron which he ignorantly expected from the *black* ore, there was disengaged an immense amount of oxygen gas, in which iron and other metals will furiously burn up with a bright flame.

BEDS OF IRON ORE.

Without attempting to give a description of all the beds and veins of iron ore in the State, the principal ones will be briefly enumerated, commencing with the brown oxyd of iron, or hematite, of the tertiary formation.

The most southern bed of this ore found in Vermont is upon the land of Eleazer Pierce, Esq., in the southern part of Stamford. We were unable to determine, beyond a doubt, the true position of the bed, but we were led to infer that it was an outlier from the formation found to exist several miles west of it, near the western base of the Green Mountains. The bed, which does not appear to be extensive, is in low land and unfavorably situated for drainage, which circumstance should deter parties from hastily embarking in the enterprise of working it.

On land of Lincoln Raymond, Esq., in the north-west part of Readsboro, are indications of the existence of hematite beds, situated like the one in Stamford. From indications presented, the inference is that the bed is not extensive, nor is the ore of good quality. Too much manganese is associated with the ore for it to produce soft and tough iron; and in the surface specimens, angular pieces of quartz were cemented with the ore, and formed a large proportion of the specimens found.

In the eastern part of Bennington there are several beds of hematite, and several old furnaces fast going to decay. At this place, which is in line with, and forms a portion of, the tertiary deposits of Western Vermont, there appear to have been good developments of iron ore, and doubtless many beds of considerable extent are now existing there.—We were unable to learn much of the history respecting those mines and of the results that attended the working of them; but it is evident that much money was needlessly expended in the erection of those furnaces, for, in our opinion, but one was needed in that locality. We noticed several adits that were driven, and excavations made, where we think ore did not exist; and, from the observations made, we would not be surprised to learn, even in this locality—where there was evidently a large amount of ore—that more money was expended in sinking shafts and driving adits where no ore existed, than all the net profits ever realized there from the manufacture of iron. Nor should we be greatly surprised to learn that the stockholders did not receive, in dividends, the amount of their original investment.

Immediately above and associated with the hematite beds, are large quantities of yellow ochre that is now being used for the manufacture of paint. Kaolin is also found at this locality, and generally found resting upon, or lying above, the beds of ochre. No lignite is found, but dark colored masses of kaolin, like those found in Brandon, that are tinged with vegetable stains, are quite abundant.

Considerable manganese was associated with the hematite seen there at the time of our visit, but these were refuse pieces, thrown aside, and were of no value for smelting. They proved, however, to be of much value to those engaged in the manufacture of stone ware in that town, for, upon calcining and reducing them to powder, they formed the coloring matter used to give the shaded tints and fine finish seen upon the spittoons and other enameled ware so extensively manufactured at Bennington. Neither manganese nor the oxyd of iron alone would produce the desired color; but, when united, as found in the worthless ore, strewed upon the ground in the vicinity of the ore beds, the proportions of each were such as to produce the beautifully mottled colors seen upon the Bennington enameled ware.

In the western part of Bennington, and within fifty rods of the State line, where there has been much local disturbance among the rocks, is a bed of hematite of considerable extent. Its situation is upon elevated ground, favorable for drainage, and quite accessible. The quality of the ore is good, and the bed, with proper management, could doubtless be profitably worked. It reposes upon an impure ferruginous limestone, similar in all respects to the silicious limestone upon which the tertiary beds of Western Vermont are found, of which this is an outlier.

In Shaftsbury, Arlington, Sunderland and Manchester, beds of hematite occur near the base of the Green Mountains; but they are of limited extent, having doubtless been mostly swept out during the drift period, evidences of which are seen in the ochery soil, and occasional fragments of iron ore found in the drift formation.

Beds of limited extent are found in the eastern part of Dorset, and one *vein* is said to exist in the town near North Dorset.* But, with due deference to that opinion, we must dissent from this conclusion; for, upon visiting the locality, and examining the "vein of ore," we were fully convinced that it was a dike composed mainly of lithomarge, that closely resembles porphyry in a plastic state, and that no iron could be extracted from it by ordinary smelting.

Wallingford produces iron ore, found in beds, about one mile east of South Wallingford village, that have been worked, but are now abandoned. They lie near the quartz rock, rounded masses of which are abundant in vicinity of this as well as at every other bed of hematite in the State. Indeed, the occurrence of these is so common in the vicinity of hematite beds, that, when occurring in large quantities they may be considered a pretty sure indication that iron ore exists, or has existed, near them; for the iron-bearing lime-

*See Prof. Adams' First Geol. Report, p. 18.

stone upon which the beds of iron are found is generally contiguous to the quartz rock formation from whence these "hard-heads" were derived.

From specimens of ore that we saw, and from information received, we inferred that much manganese was found associated with the iron in Wallingford, which was perhaps one cause of the abandonment of the beds. In some places we understand that pure hematite was found, in others comparatively pure oxyd of manganese, but in many places the iron and manganese were found so intimately blended together that they could not be separated before smelting; hence when such ore was smelted, it produced iron so hard that no drill would penetrate it, and so brittle that it was valueless for uses where great strength was required. Pure hematite, when properly smelted, always produces the best quality of tough iron, but when the ore is much adulterated with manganese its quality is greatly impaired by its brittleness and inability to withstand heat without cracking.

The impure ore obtained at Wallingford, and also some of the iron made from it, were analyzed by Prof. Olmsted* and the following were the results:

Impure Ore.		*Iron.*	
Peroxyd of iron,	71.30	Metallic iron,	88.71
Peroxyd of manganese,	12.93	Metallic manganese,	11.28
Alumina,	trace.		
Silica,	3.00		99.99
Water,	12.50		
	99.73		
Metallic iron,	49.34		

In the south-east part of Tinmouth on land of Edmund Valentine, Esq., a valuable bed of iron ore is located, that was successfully worked more than thirty years, but which is now abandoned. It is called the "Chipman bed." It is near the north end of Tinmouth Pond and at the base of a quartz hill that lies between Wallingford and Tinmouth. It may be proper here to remark that this bed does not lie in line with the beds in Wallingford, but is some miles to the west of them. Like the latter, it reposes on a silicious limestone, just west of the quartz rock. The recurrence of these rocks, to the west of those in Wallingford, is owing to a folding of the strata several miles in length, by which these rocks are thrown up as outliers from the main belt of quartz and ferruginous limestone. The "Chipman bed" is very favorably situated for working, being considerably elevated above the pond. At the time the bed was worked, a stream of water was turned so as to run over it, by which much of the overlying drift was washed off and the ore laid bare. It was of good quality and extended over considerable surface, and in some places was removed to the depth of thirty feet without reaching the bottom. There is doubtless now at that locality large quantities of good ore.

About two miles north of the last and on the same line of rock, there is another bed of iron ore, on the land of Mr. Seth Phillips. It was opened and worked fifty years ago, and not abandoned till about fifteen years since. It is favorably situated for working, and the ore obtained is of good quality. Kaolin and ochre are quite abundant, but the ore of this bed has probably been mostly removed.

See Prof. Adams' Second Geol. Report, p. 215.

In Rutland and Mendon there are indications that lead us to suppose beds of ore exist which never have been explored. The impure limestone upon which the beds are found is located near the line of the two towns.

Several beds of ore are found in the eastern part of Pittsford, near Granger's Furnace, one of which is immediately beneath it. With the ore (that rests upon limestone), there are found associated ochre, kaolin and manganese. Some of the beds have been explored, and large quantities of ore extracted therefrom. From the fact that pieces of ore are found abundantly scattered in the drift formation south of this locality it is reasonable to infer that the agencies at work during the drift period removed portions, if not whole beds of ore from this vicinity.

On a line north from the beds in Pittsford are found the Mitchell and other beds of ore in the western part of Chittenden. The excavations made at the Mitchell bed are quite extensive, and the greater portion has been of excellent quality, as the superior castings made from it at the Granger Furnace will fully attest. Although we visited this bed, descended the shaft, and traveled through its galleries, we can describe it no better than to use the words of Prof. Adams :*

"CHITTENDEN.—Three miles north-east from Granger's furnace, not far from the west line of this town, is Mitchell's ore bed. Here a shaft is sunk through drift, sixty feet, into a deposit of clayey ochres, white clay, manganese, and brown ore. Galleries have been carried a hundred feet north and south of the shaft, and to a less distance east and west. The north gallery terminates on a ferruginous limestone rock, which dips about 35° E., and contains a large irregular vein of common quartz, and on which lie, conformably, strata of the usual clayey ochres, white clay, fragments of iron ore and manganese, and occasionally silicious sand, which may have resulted from the disintegration of a rock, without disturbance of the stratification.

"The gallery, which leads south, passes these disintegrated strata, occasionally touching the rock on its west side. At the end we found what had been an object of anxious inquiry throughout this mineral region, *a solid bed of ore*, two to three yards in thickness, reposing on the limestone rock, and overlaid by the ochery strata above mentioned. A layer of yellow ochre, an inch or two in thickness, lies between the ore and the rock.

"This case is a very important one on many accounts. The immense quantities of brown ore, which have been found in this range from Bennington to the north-east part of Addison county, have hitherto consisted of detached fragments, sometimes fine as sand and gravel, but often in large lumps. In many beds these fragments have been but little mixed with the drift, and are associated, as at Wallingford, with undisturbed strata of ochres and clays. But this is the first example, in this State, of a solid bed of ore. Although the bed appears to have a northern limit in this mine, yet, since it is conformable to the limestone strata, and obviously was, before the disintegration of the overlying strata, a regularly included bed of the limestone formation, it may confidently be expected that it will never be exhausted. Another shaft, belonging to Harrison & Co., strikes the same bed about eighty feet further south, and, during the last season, has furnished an abundant supply of rich ore. It is very obviously for the interest of the owner to withdraw the labor from the attack on the solid rock in the north gallery, and to concentrate it on this bed. We were informed that the right of the present owner extends only seventy-five feet further, to the shaft of Harrison & Co.; but the bed may be followed indefinitely in its eastern descent.

"Much of the ore which has been removed from this mine was useless, from its intimate mixture with manganese; but fortunately the solid bed above described is of good quality. Granger's furnace is chiefly supplied from this bed, about forty to forty-five per cent. of iron being obtained from it. At present Mr. G. mixes with it a portion of the specular ore from New York, but without perceptible advantage. An economical arrangement of Mr. G. is worthy of notice: The slag is placed in a stamping machine, into which a stream of water is directed to wash out the vitreous portions, and the rest is remelted. Such an arrangement may perhaps be introduced into some of our forges, in which there is much waste in the slag."

*See Prof. Adams' First Geol. Report, p. 20.

About one-fourth of a mile from the Mitchell bed, in a northerly direction, there is an impure hematite, into which silex enters in large proportions. It occurs in mammillary masses, imbedded in arenaceous quartz. Too much silex enters into its composition to make it valuable for smelting, unless it be used as a flux. Prof. Olmsted analyzed specimens of this, and also some of the hematite from the solid mass alluded to by Prof. Adams, with the following results:

	Solid Ore.	*Silicious Ore.*
Peroxyd of iron,	84.90	37.81
Alumina,	.47	trace.
Silica,	.75	55.81
Water,	13.88	6.38
	100.00	100.00
Metallic iron,	58.66	26.84

In Brandon there is an excellent development of hematite, and associated with it, in beds contiguous, are vast quantities of kaolin, ochre, manganese, and brown coal. These have been more extensively and successfully worked than any other similar beds in the State. "The Brandon Iron and Car Wheel Company" own and work the principal beds in the town. To John Howe, Esq., the efficient and gentlemanly agent for the company in Brandon, we are indebted for the following description of the ore beds, their history, &c.

"Iron ore was first discovered in Brandon in 1810, and soon after a forge was built, and bar-iron of a superior quality was manufactured for several years. In 1820 a furnace was built by John Conant, Esq., for reducing the ore, an undertaking which at that time was deemed one of great hazard; but he persevered with characteristic energy and judgment, and with complete success; and it is to this furnace, long well known as "Conant's Furnace," that Brandon is indebted for an impetus then given to its business, and for its continuous growth and prosperity.

"In 1850 the furnace property, iron, and manganese mines, deposits of kaolin, &c., were purchased from the old proprietors, Messrs. John Conant & Sons, by the Brandon Iron and Car Wheel Company, who are now the only manufacturers in the United States of cold blast charcoal iron from brown hematite ores, on account of the growing scarcity of charcoal in the neighborhood of all ores of this class—a scarcity from which this company is exempt, by early and judicious purchases of over twenty-five hundred acres of heavily timbered woodlands, the timber upon which, with its natural increase, will supply charcoal for the furnace as long as wanted.

"The charter under which the company is organized was obtained from the Legislature of Vermont in 1851. Acts in addition thereto were obtained in 1852 and 1853, by which the company are empowered to hold real estate to the amount in value of two hundred thousand dollars, and the stockholders are exempted from all individual liability. The amount of capital paid in is one hundred and seventy-five thousand dollars, represented

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" The charter under which the company is organized was obtained from the Legislature of Vermont in 1851. Acts in addition thereto were obtained in 1852 and 1853, by which the company are empowered to hold real estate to the amount in value of two hundred thousand dollars, and the stockholders are exempted from all individual liability. The amount of capital paid in is one hundred and seventy-five thousand dollars, represented by seventeen hundred and fifty shares of the par value of one hundred dollars each. Of this amount, $149,845 has been paid for real estate, appropriate but not expensive buildings, well contrived machinery, fixtures, &c.

"In real estate the company own two thousand five hundred and ten acres of woodlands, situated in the towns of Brandon, Chittenden, Hancock, Ripton, and Goshen, and one hundred and two and one-half acres of mineral land, two and a half miles from the village, including the mining rights in a lot of sixteen acres, one rood, twenty-four rods, forty-seven feet, situated in Brandon, and forming one lot called the Caughey lot. This land embraces an inexhaustible supply of the valuable variety of iron ore known by the name of brown hematite; also, distinct therefrom, an extensive deposit of black oxyd of manganese. There is, also, an inexhaustible deposit of pure white kaolin, or porcelain clay, and fire clay and fire sand, and many thousand tons of pigments, including umber and ochre, that require only washing and drying to prepare them for paints.

"In connection with the clay and iron ores, there is an extensive bed of lignite, or brown coal, which has been followed from near the surface to a depth of over eighty feet. Several years past it has furnished the fuel at the mines for raising the ore and driving all the machinery. In connection, also, with the mines, and for the purpose of economically working them, the company have constructed an engine and boiler house—the latter of brick—and buildings adjoining, covering the machinery and two shafts.

"The company own furnace property in the center of the village of Brandon, about ninety rods from the station of the Rutland and Burlington Railroad, and an establishment for the manufacture of fire brick near the railroad station."

They also own buildings and fixtures for elutriating and preparing for market paints and paper clay (elutriated kaolin), which they are manufacturing in large quantities, and for which there is found a ready sale.

From C. Brownson, Esq., the intelligent superintendent of the mining operations, we obtained many facts of interest pertaining to the mine, and also a plan of the beds, of which the cut upon the following page (Fig. 332) is a reduced copy.

The rock (1) upon which the beds repose, is the same ferruginous limestone everywhere found in the State beneath hematite. It has a strike N. 30° E., and dips 40° S.E. Immediately upon the limestone—which in this mine is occasionally very silicious—there is found a bed of ochre from six to twenty feet thick.

In some places, portions of the ochre (2) are nearly black, having in its composition considerable manganese; in other places it is yellow (3), being nearly a pure oxyd of iron.

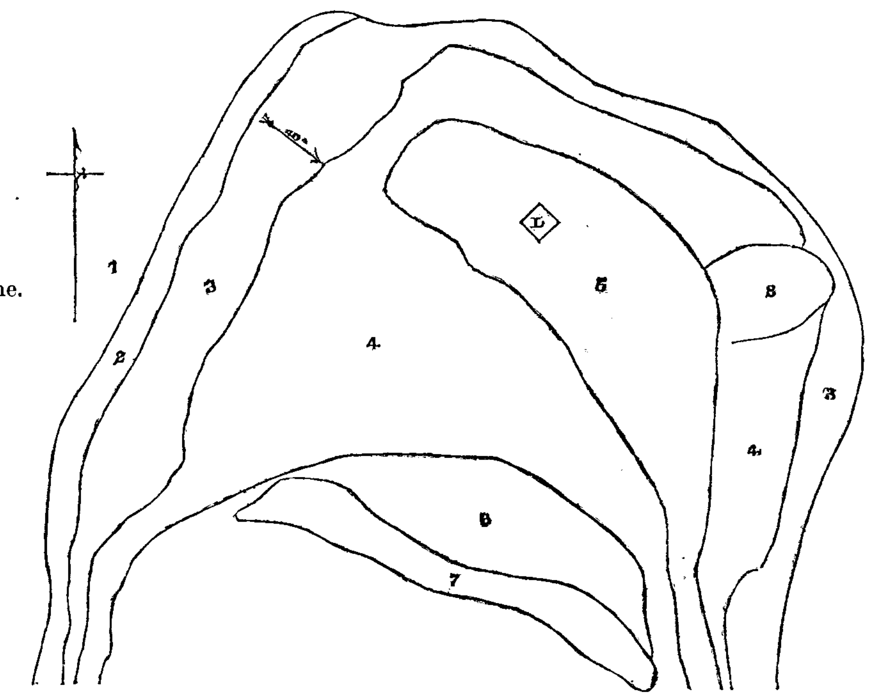
Next above the ochre, and nearly conformable with the limestone beneath, is found the hematite or iron ore (4), which has a variable thickness, and, as will be seen by referring to the cut, it also has an irregular outline.

In some places the bed of hematite has been penetrated to the depth of one hundred and four feet. The main bed is known to be six hundred feet in length, and over one hundred feet in width in some places. Ore of a superior quality is found in this bed, and the iron made from it is remarkably tough, and well suited for the manufacture of car wheels, cannon, machinery and weighing scales, for which it has lately been principally used.

Next above the hematite is found the bed of kaolin or white clay (5), which is quite extensive, and has an average dip of about 40° S.E. In this bed of kaolin which comes to the surface in several places, is a mass of lignite or brown coal (L) about twenty-five feet *square*, standing in a perpendicular column, and extending down obliquely through it.

FIG. 332.

Explanation.
1 Ferruginous Limestone.
2 Black Ochre.
3 Yellow Ochre.
4 Hematite (Iron Ore.)
5 Kaolin (White Clay.)
6 Red Kaolin.
7 Dead Ore.
8 Quartz Sand.



Ground Plan, showing the relative Position of the various Deposits of Ore, &c., in Brandon Ore Beds.

A bed of quartz sand (8) of considerable size is found resting upon the kaolin, and several small deposits are found in beds adjacent. It is also sometimes found mixed with kaolin. It is valuable for moulding sand, and has been considerably used in the manufacture of fire-brick, for which it is admirably suited. In the beds of sand are found small masses of arenaceous quartz, that still retain their rocky form, but so friable as to be readily separated with the fingers.

When sand is found mixed with kaolin, the latter is usually stained more or less with ochre, and in some instances it is found of a dark-red color.

A bed of reddish kaolin (6) is found resting upon the southern side of the main bed of hematite, and overlying a bed of "dead ore" (7). This dead ore—which is found more or less in all hematite beds—is worthless for smelting, and intelligent miners assert that it always occurs "where the water is cut off from the bed." It is claimed by many miners, that all hematite beds are injured by taking the water from them, and that when mines are temporarily abandoned, water should be suffered to accumulate in them for the preservation of the ore.

In a southerly direction from the bed just described, and not more than sixty rods distant, is located the Forestdale or Blake ore bed. In this there is the same sequence of ochre, ore, kaolin, &c., that exists in the former bed, and the dip and appearance of the bed-rock beneath both are similar. In the midst of the kaolin is a mass of brown coal, closely resembling that found in the northern bed, but not so extensive a deposit. To describe these beds, and the order of their recurrence, would in substance be a repetition of what has already been said respecting the northern bed.

The Blake bed is not worked at present, neither for ore nor for any of the associated minerals, but doubtless contains large deposits of both.

Aside from these two principal beds of ore, there are numerous smaller beds of hematite, ochre, manganese, &c., found in this vicinity, some of which are quite valuable.

Small deposits of iron ore exist in Leicester, Salisbury, Middlebury and Bristol, but none that are extensive. Manganese and yellow ochre are very abundantly disseminated with the iron ore found at these places, and would doubtless prove valuable in the manufacture of paints.

In the south part of Monkton, near Bristol line, is a bed of iron ore owned by "The Boston Iron Company," but not worked at present. Professor Thompson gave the following description of the ore: "Ochery varieties occur, but it is mostly the hematitic brown oxyd. The color of the surface of the ore is a velvet-black, and that of the interior a brownish-black. Its structure is fibrous and commonly radiated. This ore makes excellent iron, and is manufactured at Bristol and other places. Connected with this ore is found the black oxyd of manganese." From the description given of the ore, we should infer that iron made from the "velvet"-colored variety would be too hard and brittle to be successfully used for stove plates and soft castings. We strongly suspect manganese entered largely into the composition of the ore, and produced the beautiful black color. The bed is not favorably situated for drainage, but is supposed to contain considerable quantity of ore.

Like the deposits of carbonate of lime which form the beds of marble in Vermont, the ferruginous limestone beds also thin out as they approach the north part of the State; and, as might be expected—if our conjectures are well founded as to their origin—the beds of hematite are less numerous and extensive in the north, than in the middle and southern portions.

Hematite beds probably exist in Hinesburgh, Huntington and Williston, but we know of no good developments of them in these towns.

A deposit of ore of good quality, but not extensive, is found in Colchester, about one mile north of the depot, on land of Mr. J. Barnes. It occurs in a recess between two considerable spurs of silicious limestone. It is probable that the bed was originally much more extensive than at present, but was removed by drift agency, as there are found numerous fragments of the ore in drift south of the bed.

In Milton, Georgia, Swanton, St. Albans, Franklin and Highgate, small deposits of ore are found, but the beds are all small, and probably not valuable for working.

In the southern part of Plymouth, east of the Green Mountains, is a deposit of hematite of considerable extent. It was worked for several years by Isaac Tyson, Esq., but the beds are now abandoned, and the furnace buildings are fast going to decay. As before suggested, we regard this as an outlier and counterpart of the extensive tertiary deposit found upon the west side of the mountains. Quartz sand, kaolin and manganese are found associated with the iron, and occur in beds nearly conformable with the beds of rock beneath. J. W. Stickney, Esq., of Plymouth, informs us that in driving an adit from the east, the workmen, after passing through the drift, encountered a bed of kaolin and quartz sand, having a thickness of about five rods. Through this bed the adit was driven, and after passing through an ochre bed the hematite was reached. Beneath the ore there was a bed of ochre resting upon, and conformable with the bed-rock which dips about 40° E. So much manganese enters into the composition of the ore that it is not always valuable for the manufacture of soft iron, and it was necessary to assort the ore, and separate the manganese from the hematite, before the latter could be advantageously smelted. There were portions of the bed in which a good hematite was found, as will be seen from the following analysis of a specimen of the brown hematite, by T. S. Hunt, of the Geological Survey of Canada:

Peroxyd of iron,	83.03
Silica,	2.53
Water,	14.50
	100.06

Other beds of hematite may exist, and indeed we know that some small ones do exist, that are not particularly described; but we have given those that are the most valuable and accessible.

BOG ORE.

To describe minutely the numerous beds of bog ore found in the State, would be a difficult task, for in every county scores of them are found. But with the full conviction that not one of these numerous beds is valuable for smelting, or would produce iron enough to defray the expense, even if the furnace were built and ready to receive the ore, we deem it useless to minutely describe even one of them.

Unlike the beds of hematite, bog ore beds are confined to no particular rock formation, and are found upon the mountains and in the valleys. In every marshy spot, where rocks containing pyrites or carbonate of iron are contiguous, there may be found more or less of the earthy oxyd of iron. It even enters largely into the composition of the soil in some localities, and gives to it the yellow color. But while it is so generally distributed through the State, it is a little remarkable that no beds have ever been found that were of a magnitude that would warrant an outlay of much capital to work them.

RED HEMATITE.

This ore, usually called the red oxyd of iron, is not abundant in the State, but is found to some extent in the north-western part of it. It occurs in Milton, Fairfield, Enosburgh and Berkshire. In the former town, it is found near the margin of Lake Champlain, on land of Mr. Orange Phelps. Several years since sixty tons of the ore were taken out and smelted, and it proved to be a rich ore, especially that portion taken from near the middle of the bed.

In Fairfield another bed of this ore is found, but it is not extensive. The following analysis made by Prof. D. Olmsted will show the relative value of the ores from Milton and Fairfield:

	Milton.	*Milton.*	*Fairfield.*
Peroxyd of iron,	98.30	98.22	95.71
Protoxyd of iron,	97		trace.
Peroxyd of manganese,	trace.		
Silica,	91	1.78	3.91
	100.18	100.00	99.62
Metallic iron,	69.00	68.10	66.36

The above variety may be recognized by its giving a red streak and powder with a file, and becoming slightly magnetic when heated. This, like the artificial peroxyd, is used for polishing under the name of *blood stone*, and when found in workable quantities is valuable for smelting.

LOADSTONE.

The magnetic oxyd of iron is found in amorphous and lamellar masses, and also in octahedral crystals and minute grains. The streak and powder of this ore is always black. It has a color and luster approaching that of metallic iron, and is invariably attracted by the magnet. In some instances it possesses polarity enough to turn by magnetic influence when suspended with a string. This, and titaniferous oxyd of iron ore form the greater portion of the "black sand" so abundant in auriferous deposits of Vermont. Although magnetite is extensively distributed in the rocks of Vermont in octahedral crystals, yet it is rarely found in workable quantity. It is a rich ore, and when smelted produces an excellent iron.

Only two beds of ore of this variety have ever been worked in the State,— one at Somerset, and one at Troy in connection with the titaniferous oxyd of iron. The bed at Somerset was worked several years since, and all the workable ore that was accessible taken out, and the bed abandoned. It was highly magnetic.

The titaniferous iron ore of Troy had associated with it masses of magnetic ore, which produced iron of an excellent quality. It was found interstratified with serpentine, and formed a bed (?) from one to four or five feet wide, and nearly perpendicular. Considerable ore has been taken from that bed, and there are portions of considerable extent still remaining.

Other small deposits of magnetic iron are found in the State, as at Bear Hill in Ludlow, also in Plymouth, Rochester, &c., but in no case in workable quantities.

The micaceous and specular oxyds are sparingly disseminated in the rocks of Vermont, but are rarely found in large quantities. Small quantities are found in Weathersfield in connection with the beds of dolomitic limestone, and small veins in Plymouth. By the disintegration of rocks, small scales of this ore are liberated, and may often be seen in the highway after a shower has washed the road.

SULPHURET OF IRON.

Sulphuret of iron, or iron pyrites, is an abundant mineral, and found associated with every kind of rock in the State. For smelting it is not only valueless, but, when used in connection with other ores, it proves highly injurious. It occurs in beds and also in cubes and other crystalline forms. Its color is a bronze-yellow, passing into a steel-gray, with a brilliant metallic luster. From its color it is often supposed to be gold, but the latter is malleable and may be hammered into thin plates, while pyrites is brittle and will

crumble under the hammer. Pyrites, when reduced to powder and thrown upon coals or a heated iron, will emit a sulphurous odor and turn black.

Two large deposits of this are found in the State, one at Cuttingsville and one in Strafford. These beds have both been worked for "copperas ore," a name given to the pyrites, and copperas has been extensively manufactured at the two places. The beds at Cuttingsville are abandoned, and the buildings in which the copperas was manufactured taken down. The bed of pyrites is upon a hill, in full view from the Rutland and Burlington R. R. approaching Cuttingsville from the east, and upon the land of Mrs. Calvin Robinson. This bed is interstratified with the adjacent rock, and is conformable with it, having a strike N. 70° E., and a dip 30° S.E.

A gneissoid rock with occasional sprinklings of hornblende, lies under the bed of pyrites, and immediately above it is an impure limestone, in which are found concretionary and crystalline masses of calcite.

The bed is favorably situated for working, being upon a hill-side, and within a few rods of the railroad. It is extensive, and should the demand for copperas be so great as to warrant an outlay of capital sufficient to erect new buildings in any place in New England, here would be a good place to make the investment; for aside from the value of the bed as one producing copperas ore, we believe there will be found associated with the sulphuret of iron, at greater depths than have yet been reached, a cupriferous deposit that may prove extensive and valuable.

In our remarks upon tin, it will be seen that we are disposed to believe tin, as well as copper, to be associated with this immense deposit of iron pyrites.

STRAFFORD COPPERAS WORKS.

The bed of pyrites at Copperas Hill, in the south-east part of Strafford, is one of the largest metaliferous deposits in New England. It is a bed interstratified with the adjacent rock for an indefinitely long distance, and has a thickness, in some places, of seventy feet. The strike of the bed and adjacent rock is N. 10° E., with a dip 50° to 80° E. The strata are curved, and hence is occasioned the difference in dip. At the surface the dip is 50° E., but in an adit being driven — with the hope of finding copper—two hundred feet below, the dip is found to be 75° E. The unusual phenomena presented at the surface of the ground, over the pyrites, occasioned by its decomposition, arrested the attention and awakened the curiosity of the people in the vicinity, several years before the character of the bed was understood. By some it was supposed to be iron ore, of a kind valuable for the production of iron, and a large quantity of it was taken to a furnace in Franconia, N. H., for the purpose of smelting. It was mixed with the rich ore of Franconia, and put into the furnace, but instead of getting a supply of iron from the Strafford ore, the disengaged sulphur prevented even the flow of iron from the Franconia ore, and the result was, that the furnace was blocked up, and no more ore could be smelted therein till the sulphurous mass was removed, which was done at great expense.

In 1809, the nature of the ore having been sufficiently determined, the manufacture of copperas was commenced by a company styled "The Vermont Mineral Factory Company." Most of the time since then, the manufacture of copperas has been successfully carried on at this place, but during the last twenty-five years the work has been prosecuted by "The Vermont Copperas Company," of which John Reynolds, Esq., is Agent. To him we are mainly indebted for the following facts relative to the manufacture of copperas.

The process consists in first raising the ore from the bed, which is principally done with the help of gunpowder. The blocks of ore are then broken up into small pieces, to facilitate the decomposition, by suffering the oxygen contained in water and the atmosphere to come more directly in contact with the material composing the ore. Large heaps of these pieces, called leaches, are made upon a tight plank bottom, or upon a sloping ledge of solid rock, where the liquor or lye that subsequently runs from them may be saved.

In dry weather, a small stream of water is made to flow upon, and penetrate these leaches, in order to produce a spontaneous combustion, which in warm weather commences in a few days, and if properly managed will continue several weeks. When combustion is taking place, great care is requisite in order to have the work go on successfully, for if too much water is suffered to penetrate the leach or heap, the decomposition is checked by the reduction of temperature, and the lye or liquor issuing from it is too weak to be valuable; and if there is not water enough put on the leach, the decomposition is also arrested by the absence of the oxygen found in the water, which is necessary to convert the sulphurous acid into the sulphuric, that sulphate of iron or copperas may be produced.

The liquor that runs from the leaches is collected in reservoirs, from which it can be taken at pleasure. Below the reservoirs upon the hill-side, buildings are erected, called *evaporators*, to which the liquor is conducted in troughs from the reservoirs in small streams, that are divided and sub-divided by means of perforated troughs, brush, &c. Several tiers of brush are arranged in the building, through which the liquor is made to pass to facilitate the process of evaporation. In dry, windy weather, the evaporation is oftentimes so rapid that the brush and other substances with which the liquor comes in contact during the latter part of its journey, often have an incrustation of copperas formed upon them; but, upon the return of rainy weather, the humid atmosphere checks the evaporation, and the crust of copperas is dissolved and passes with the liquor into reservoirs prepared to receive it.

The liquor, which is now very strongly impregnated with copperas, is conducted into leaden boilers, where heat is applied and the liquor reduced to a strength indicated by the acidimeter to be right for the production of copperas. The liquor is then placed in vats of lead or of brick and water cement, called *crystallizers*, and after remaining from eight to ten days, a crust of copperas is formed upon the bottom and sides of the vats, composed of nicely formed crystals. The water remaining in the crystallizers is then pumped back into the boilers, the crust of copperas removed, and, after being sufficiently drained, it is packed in casks ready for market.

There are many uses to which the sulphate of iron can be advantageously applied. In dyeing black, and in the manufacture of writing ink, it has been extensively used. It is also an excellent disinfectant, one of the best that can be used for purifying sewers and drains, for the ammonia as well as the sulphureted and phosphureted hydrogen, which together concur to produce the nauseous effluvia, are at once condensed by this salt—the ammonia by its acid, and the gases by its oxyd.

Where sewers and drains are made of wood, copperas not only checks the odor that would arise, but it also protects them from decay. Wood and cordage may be kyanized with a strong solution of copperas, by which their value is much enhanced, if they are to be placed in situations exposed to the rotting influence of moisture. Shingles may be made much more durable by being immersed in a strong solution of the sulphate of iron, till they become thoroughly saturated, before they are placed upon the roof. As evidence of its value in protecting timber from decay, it may be proper to state, that the plank and timber used in the construction of the first leach bottoms (in 1809), at Copperas Hill, are now perfectly free from rot, and the timbers of the buildings, and all the wood used about the works, where it has become thoroughly saturated with copperas, is now perfectly sound. Would not our railroad companies and mill owners do well to copy from these examples?

As an absorbent of the volatile gases, it must be valuable in agriculture, when sprinkled with the stable manure or mixed with a heap of compost.

In Paris, large quantities of fœcal matter are collected and mixed with a solution of copperas, which renders the compound inodorous by condensing the nauseating and volatile gases, and forms one of the most valuable manures used by farmers. When dried and shipped to this country, it is sold under the name of *poudrette*. How many farmers there are who purchase this imported article, but never manufacture it,—they suffer the ammonia and nauseating effluvia to escape from their privy vaults, rendering them oftentimes perfect nuisances, when, with frequent solutions of copperas applied, the contents would become inodorous, and one of the most valuable fertilizers any where to be found. The low price at which it is sold (two or three cents per pound), places it within the reach of such as would be benefited by its kyanizing, disinfecting or fertilizing qualities.

Except for the purposes of manufacturing copperas, iron pyrites is not valuable, hence localities will not be definitely enumerated; but it may be proper to state that there is probably no town in the State where it does not exist. It is often mistaken for gold, by those who do not understand its character, and much money has been foolishly expended in collecting it, hence it has received the name of "fool's gold."

When it occurs in a fissile slate, it becomes decomposed to great depths, and produces at times a black tarnish which is well calculated to deceive the casual observer. With some, this black tarnish, which soils the fingers, is a sure indication of the existence of black lead or graphite. Several explorations have been made for more solid and pure graphite, than that shown at the surface of these "black lead veins," but in every instance of this kind the rock has gradually become more solid, and less plumbaginous as it has been penetrated; and when taken from suitable depths, is found to have disseminated through it minute grains or crystals of the sulphuret of iron, but no graphite.

Again, these blackened rocks indicate to others that *coal* is to be found in them. Hundreds of dollars have been expended in this State, in the vain search for coal in the slates of the Hudson River group of rocks and their associates, in consequence of their black and carbonized appearance. The "crocky" quality of these slates is often the result of the decomposed sulphurets, that are disseminated in small grains through them. The proof of this will be manifest to any one who will blast out the fissile portions, and examine the sound rock with a magnifier, when the pyrites will be seen; or pulverize a portion of it, and throw the powder upon a red-hot iron, when the sulphurous fumes will immediately rise, and be readily recognized by their odor.

To those, therefore, who have not been made acquainted with the fact that coal beds are never found in rocks as *old* as those alluded to, the tests above given may serve as a beacon, and dissuade them from engaging in the foolish enterprise of digging for coal in Silurian rocks.

ARSENICAL IRON ORE.

Mispickel, or arsenical pyrites, is not an abundant mineral in Vermont, but is occasionally found. It has, upon a fresh fracture, a white metallic luster, so much resembling metallic silver or tin that many a person has mistaken a vein of arsenical iron for a silver mine. It may be known by throwing some of it, reduced to powder, upon a hot iron, when there will arise from it white fumes that have an odor of garlic. It has no economical value as an ore of iron, but arsenious acid, or the white oxyd of arsenic of the shops, may be obtained from it by sublimation. The best locality of mispickel, of which we have any knowledge in the State, is in Brookfield, a short distance from the north-east corner of the town of Braintree.

CARBONATE OF IRON.

Spathic iron, although quite extensively disseminated in rocks, is but rarely found in workable quantities. It has a foliated structure, vitreous luster, and a yellowish or buff color, which upon exposure assumes a reddish-brown or brownish-black. It is not successfully used for the manufacture of common cast iron, but for steel or malleable iron it is valuable. The metal produced from it is hard, white and splendent, but by being annealed in ovens prepared for the purpose at the manufactories of malleable iron, it becomes soft, tough and ductile.

We know of but one locality in the State, where the ore occurs in workable quantity. This is situated in the south-east part of Plymouth, about one-half mile from the meetinghouse. It occurs in two beds, interstratified with talcose slate, and about twelve feet from each other. The widest bed is about five feet thick, and the other about three feet. The bed, and rock inclosing it, have strike N. 10° E., and a dip 55° E. The edges of the beds are exposed in spots, for the distance of about twenty rods, and there is doubtless quite a large deposit of ore at this place.

An attempt was made to use this ore in connection with hematite, for the manufacture of common cast iron in Tyson Furnace, but the product was so hard and brittle as to render it valueless for the manufacture of stoves, or other soft castings.

CHROMIC IRON.

This ore, though not valuable for smelting, is more highly prized than any other ore of iron. Indeed, a ton of this ore will sell for more than a ton of pig iron, for in it is contained the basis of the chromate of potash, chrome-green, chrome-yellow, &c. It resembles, in color and appearance, the specular oxyd of iron—being nearly black, having a conchoidal or uneven fracture and a dull metallic luster. It is found disseminated in crystalline masses, and in small veins, in nearly all the localities of serpentine in the State,

but we have seen no large deposits of it. It seems to be the most abundant in the northern part of the State, in the towns of Lowell, Westfield, Troy and Jay.

Prof. Adams, in his Second Report on the Geology of Vermont, p. 220–5, speaks of the localities of chromic iron, its uses, &c., as follows:

"JAY. In the east part of this town, about sixty rods west of the middle of the east line, is a serpentine range, on land of Enos Farwell, where our attention was called to some "iron ore," which proves to be chromic iron ore of excellent quality, within three rods of a good road, and near water power. It occurs in veins somewhat irregular, of which the largest is from one to two feet wide; and we were assured by Mr. F. that it also occurred at a spot some thirty rods north, which we perceived to be in the direction of the vein, but the circumstances of our visit prevented further exploration. The great importance of this discovery was readily understood, and several individuals have followed up this with additional discoveries, of which we are unable at present to give a description. The principal vein which we examined in person, now belongs, as we are informed, to W. W. Huse, Esq., whose skill and enterprise, so advantageously exhibited in the management of the Troy furnace, may be expected to render the ore available.

"A partial analysis has been made by my friend and college associate, Professor Twining, who has made one hundred and eighty grains of chrome yellow from one hundred of the ore, without exhausting the chromic oxyd of the latter. The appearance and specific gravity indicate its richness.

"WESTFIELD. We have examined the locality mentioned by Mr. Hall last year, and find a small irregular vein, which does not indicate anything conclusive on the workable value of the ore.

"There appear to be various compounds of the oxyd of chrome with peroxyd of iron and with alumina, as may be seen in the following list of analyses:

Analyst.	*Locality.*	*Oxyd of Chrome.*	*Peroxyd of Iron.*	*Alumina.*	*Silex.*	*Manganese.*
Thomson,	Shetland,	56.00	31.00	13.00		
Laugier,	Siberia,	53.00	34.00	11.00	1.00	1.00
Seybert,	Chester, Mass.,	51.56	35.14	9.72	2.00	trace.
Klaproth,	Krieglock,	55.50	33.00	6.00	2.00	
Bertheir,	St. Domingo,	56.00	37.00	21.50	5.00	"White
Vauquelin,	Var, France,	53.70	34.70	20.30	2.00	substance."
Thomson,	Baltimore,	52.95	29.24*	12.22	trace.	3.09
Beudant,	Baltimore,	39.50	36.00	13.00	10.60	Magnesia.
Beudant,	Roeras,	54.08	25.66	9.00	4.83	5.36
Abich,	(?)	60.04	20.13	11.85		7.45

"From the imperfect analysis made of the Jay ore, we may hope that it will prove to be one of the richer varieties.

"This ore much resembles in structure and color the magnetic iron ore, but it is easily distinguished by a very feeble or no magnetism; by the brown streak (powder); and by the beautiful emerald-green glass obtained by fusion of a small fragment in borax, the glass by a similar process with magnetic iron ore being of a dingy-olive or bottle-green.

"Since one hundred grains of the pure mineral will yield about two hundred and twenty-five grains of chrome yellow, we may, in anticipation of an analysis, perhaps safely reckon that this ore will give double its weight of chrome yellow; and, since this is worth about six hundred dollars per ton, a ton of the best of the ore will produce about twelve hundred dollars. But it must be remembered that the cost of raising the ore is one of the least of the expenses of the manufacturer, as may be seen from the fact that in manufacturing one ton of the ore, about two thousand seven hundred and eight-six pounds of niter, and five thousand two hundred and thirty pounds of sugar of lead, would be requisite for the product above mentioned. This estimate supposes no waste of any of the materials, being based on their chemical equivalents. Probably a considerable excess of the ore would prevent any great waste of the more costly materials. The

*"Protoxyd"?

substitution of potash and peroxyd of manganese, both of which may be obtained within the State at a very low price, in the place of niter, may considerably reduce the expense. The present market value of good ore is forty dollars per ton.

"In order to show the uses of an ore, which is likely to be found abundantly in the region above mentioned, but with which our community in general is but little acquainted, I have thought it expedient to subjoin the following rather long extracts from a work which should be in the hands of every person engaged in mining or manufactures,—Ure's Dict. of Arts, Manufactures, and Mines:

"'The chief application of this ore is to the production of chromate of potash, from which salt the various other preparations of this metal used in the arts are obtained. The ore, freed, as well as possible, from its gangue, is reduced to a fine powder, by being ground in a mill under ponderous edge-wheels, and sifted. It is then mixed with one-third or one-half its weight of coarsely bruised niter, and exposed to a powerful heat for several hours, on a reverberatory hearth, where it is stirred about occasionally. In the large manufactories of this country, the ignition of the above mixture in pots is laid aside, as too operose and expensive. The calcined matter is raked out and lixiviated with water. The bright-yellow solution is then evaporated briskly, and the chromate of potash falls down in the form of granular salt, which is lifted out from time to time from the bottom with a large ladle perforated with small holes, and thrown into a draining box. This saline powder may be formed into regular crystals of neutral chromate of potash, by solution in water and slow evaporation; or it may be converted into a more beautiful crystalline body, the bichromate of potash, by treating its concentrated solution with nitric, muriatic, sulphuric, or acetic acid, or, indeed, any acid exercising a stronger affinity for the second atom of the potash than the chromic acid does.

"'Bichromate of potash, by evaporation of the above solution and slow cooling, may be obtained in the form of square tables, with beveled edges, or flat four-sided prisms. They are permanent in the air, have a metallic and bitter taste, and dissolve in about one-tenth of their weight of water, at 60° F.; but in one-half of their weight of boiling water. They consist of chromic acid thirteen, potash six; or, in one hundred parts, 68.4+31.6. This salt is much employed in calico-printing and in dyeing.

"'Chromate of lead, the chrome-yellow of the painter, is a rich pigment of various shades, from deep-orange to the palest canary-yellow. It is made by adding a liquid solution of the neutral chromate (the above granular salt) to a solution, equally liquid, of acetate or nitrate of lead. A precipitate falls, which must be well washed, and carefully dried out of the reach of any sulphureted vapors. A lighter shade of yellow is obtained by mixing some solution of alum, or sulphuric acid, with the chromate, before pouring it into the solution of lead; and an orange tint is to be procured by the addition of subacetate of lead, in any desired proportion.

"'For the production of chromate of potash from chrome ore, various other processes have been recommended. The following formulæ, which have been verified in practice, will prove useful to the manufacturers of this important article:

I. Two parts of chrome ore, containing about fifty per cent. of protoxyd of chromium.
One part of saltpeter.

II. Four parts of chrome ore, containing thirty-four per cent. of protoxyd of chromium.
Two parts of potashes.
One part of saltpeter.

III. Four parts of chrome ore, containing thirty-four per cent. of protoxyd of chromium.
Two of potashes.
Four-tenths of a part of peroxyd of manganese.

IV. Three parts of chrome ore.
Four parts of saltpeter.
Two parts of argal.

"'Some manufacturers have contrived to effect the conversion of the oxyd into an acid, and of course to form the chromate of potash, by the agency of potash alone, in a calcining furnace, or in earthen pots fired in a pottery kiln.

"'After lixiviating the calcined mixtures with water, if the solution be a tolerably pure chromate of potash, its value may be inferred, from its specific gravity, by the following table:

At specific gravity	1.28	it contains about	50	per cent. of the salt.
	1.21		33	
	1.18		25	
	1.15		20	
	1.12		16	
	1.11		14	
	1.10		12	

"'In making the red bichromate of potash from these solutions of the yellow salt, nitric acid was at first chiefly used; but, in consequence of its relatively high price, sulphuric, muriatic, or acetic acid has been frequently substituted upon the great scale.

"'There is another application of chrome which merits some notice here: that of its green oxyd to dyeing and painting on porcelain. This oxyd may be prepared by decomposing, with heat, the chromate of mercury, a salt made by adding to nitrate of protoxyd of mercury, chromate of potash, in equivalent proportions. This chromate has a fine cinnebar red, when pure; and, at a dull red heat, parts with a portion of its oxygen and is mercurial oxyd. From M. Dulong's experiments it would appear that the purest chromate of mercury is not the best adapted for preparing the oxyd of chrome to be used in porcelain painting. He thinks it ought to contain a little oxyd of manganese and chromate of potash, to afford a green color of a fine tint, especially for pieces that are to receive a powerful heat. Pure oxyd of chrome preserves its color well enough in a muffle furnace; but, under a stronger fire, it takes a dead-leaf color.

"'The green oxyd of chrome has come so extensively into use as an enamel color for porcelain, that a fuller account of the best modes of manufacturing it must prove acceptable to many of my readers.

"'That oxyd, in combination with water, called the hydrate, may be economically prepared by boiling chromate of potash, dissolved in water, with half its weight of flowers of sulphur, till the resulting green precipitate ceases to increase, which may be easily ascertained by filtering a little of the mixture. The addition of some potash accelerates the operation. This consists in combining the sulphur with the oxygen of the chrome acid, so as to form sulphuric acid, which unites with the potash of chromate into sulphate of potash, while the chrome oxyd becomes a hydrate. An extra quantity of potash facilitates the deoxydizement of the chromic acid by the formation of hyposulphite and sulphuret of potash, both of which have a strong attraction for oxygen. For this purpose, the clear lixivium of the chromate of potash is sufficiently pure, though it should hold some alumina and silica in solution, as it generally does. The hydrate may be freed from particles of sulphuric acid upon it, which dissolves; after which it may be precipitated in the state of a carbonate, by carbonate of potash, not added in excess.

"'By calcining a mixture of bichromate of potash and sulphur in a crucible, chromic acid is also decomposed, and a hydrated oxyd may be obtained; the sulphur being partly converted into sulphuret of potassium, and partly into sulphuric acid (at the expense of the chromic), which combines with the rest of the potash into a sulphate. By careful lixiviation, these two new compounds may be washed away, and the chrome-green may be freed from the remaining sulphur by a slight heat.

"'Liebig and Wöhler have lately contrived a process for producing a subchromate of lead of a beautiful vermilion hue. Into saltpeter, brought to fusion in a crucible at a gentle heat, pure chrome-yellow is to be thrown by small portions at a time. A strong ebullition takes place at each addition, and the mass becomes black, and continues so while it is hot. The chrome-yellow is to be added till little of the saltpeter remains undecomposed, care being taken not to overheat the crucible, lest the color of the mixture should become brown. Having allowed it to settle for a few minutes, during which the dense basic salt falls to the bottom, the fluid part, consisting of chromate of potash and saltpeter, is to be poured off, and it can be employed again in preparing chrome-yellow. The mass remaining in the crucible is to be washed with water, and the chrome-red being separated from the other matters, is to be dried after proper edulcoration. It is essential for the beauty of the color that the saline solution should not stand long over the red powder, Mr. Hartwell furnished another chemist (?) with specimens of a hornblendic dike in the vicinity of this tin mine, and was informed that "the dark-colored rock yielded of iron 14.22 per cent., of tin 2.30 per cent." We shall also venture to put down this analysis in the same category with the other.

It is not improbable, however, that tin may exist in veins that traverse the Adirondacks; still, it is hardly reasonable to expect valuable ores of tin at or near the surface either in that region or in Vermont. The places where tin ore will ever be worked with profit, are doubtless in the copper mines after they shall have been explored at sufficient depths. It would not be unprecedented or surprising, when a shaft has been sunk in the sulphuret of iron—"copperas ore"—at Cuttingsville, if good veins of tin ore were encountered, still at present the indications are not such as to warrant an investment of capital that would be required to carry on the work.

We are informed that tin ore has been found in Royalton on land of Hon. John S. Marcy, and that metallic tin was obtained from it by Dr. Jackson of Boston, but not having examined the locality we are not prepared to report upon it.

LEAD.

Of the several ores of lead—galena, or the sulphuret of lead, is the principal ore from which the lead of commerce is obtained. This ore has a brilliant metallic luster when first taken from the mine, but turns dark and less lustrous upon long exposure. It has a crystalline structure, and oftentimes upon the surface presents an appearance like an aggregation of cubes, and a color closely resembling newly cut metallic lead or tin.

The best development of lead ore in the country—if not in the world—is near the north-west corner of Illinois in that State, Wisconsin and Iowa. Although lead ore is found in rocks, differing in age and lithological characters, yet in this instance it is restricted to an undisturbed sedimentary rock formation, the maximum thickness of which is less than three hundred feet. It is a porous magnesian limestone, known in geology as the Galena limestone, and has a position in the Silurian rocks between the Trenton limestone and the Hudson River group.

Numerous fissures and small caverns or "openings" abound in the Galena limestone, and the sides of these are oftentimes incrusted with deposits of the sulphuret of lead, the surfaces of which are studded with cubic crystals of ore that are generally perfect in their form, and afford very beautiful and valuable specimens. We have in Vermont undisturbed beds of Silurian rocks, some of which are nearly synchronous with the Galena limestone, but in none of them are found indications favorable to the existence of lead. Indeed the Galena limestone formation, so conspicuously shown in Wisconsin, Iowa and Illinois, is not developed at all at the east. Small veins of galena have, however, been found in some of the metamorphic rocks of the State, and a brief description of those that have come under our observation will be given.

THE LEAD MINE AT THETFORD

Will first be described. It is situated about one-half mile north-east of Thetford Hill, in a vein traversing strata of talcose slate. The rocks at this place have a strike N. 20° E., with a variable dip—being in some places 35° E. and in others, further south, 75° E.

Six openings have been made upon the vein, and in one place a shaft has been sunk to the depth of about one hundred feet. The ore occurs in a *gangue* or vein-stone composed of quartz, calcareous spar, blende, &c., that has a strike nearly north-east and south-west with a dip of 20° S.E. The vein is a thin one, being rarely found more than two inches thick, and in many places the galena is completely "pinched out" for considerable distances.

With so small a vein, and occurring in hard talcose slate, it was deemed advisable to abandon the work that had proved so unprofitable to those engaged in it. At the time of our visit, the excavations were filled with water, and the buildings connected with the mining interest fast going to decay.

NORWICH LEAD VEIN.

About forty rods west of the residence of Jacob Newcomb, Esq., near the line dividing Norwich and Thetford, is located a lead "mine" belonging to Hon. Stephen Thomas, of West Fairlee. The rocks in this vicinity give evidence of having been greatly disturbed. Indurated talcose slate twenty rods east of the vein of lead, has strike N. 20° E., and dips 42° E., but the same rock at the vein has a dip 45° W. There has not been as great expenditure of money here as at Thetford, and the indications are not such as should warrant an investment of much magnitude to work the mine. Like the Thetford vein this is small, and occurs in a gangue of calcareous spar, blende, &c.

The soil is discolored for a considerable distance from the vein, by the decomposed portions of this metalliferous deposit, and were the same "prospect" presented in the Galena limestone near Dubuque, Iowa, that is found here, the "claim" would be eagerly sought for, and perseveringly worked in that lead bearing region. But even there it might not pay well, but the chances for finding workable veins in those cavernous rocks are far more favorable than in the compact schists of Vermont.

MORRISTOWN LEAD MINE.

In the eastern part of Morristown, on land of Elias Metcalf, Esq., the soil is much discolored by a metalliferous vein that occurs in the talcose slate, and runs nearly in a line with its strata. The gangue has a strike N. 10° E., and dips 85° W., and in it are found the sulphurets of lead, zinc and iron, and also the carbonate (?) of iron. It has a thickness of sixteen to twenty inches, and its outcrop may be traced more than ten rods.

An excavation has been made upon the vein about ten feet long and eight feet deep, but no material change in its character was observed, nor was there much lead obtained. The sulphuret of lead is quite sparsely disseminated in the veinstone, and the chance for getting a ready supply "for bullets," is very far from being equal to what tradition says the "old Indian" had, who, "when the country was new," used to go and chop it from the leaden ledges of Elmore Mountain, that is in full view, and not far south of this locality.

Galena is also found in Bridgewater, in connection with the auriferous veins of that town—in Plymouth near the gold washings—upon Dorset (Eolus) Mountain near its eastern base, and also in Chittenden, at a famous "lead mine," where doubtless the money expended (or time, and time is money), if converted into silver coin would far outweigh all the lead ever found there, and in several other places in the State. But in none of these localities, and perhaps we might add those three before described, are the indications sufficiently favorable to warrant the outlay of capital requisite to make a fair trial upon a mineral vein.

In regard to the existence of lead in workable quantity in the metamorphic rocks of Vermont, we fully concur in the conclusions arrived at by Prof. Adams, in his Second Geol. Report,* and here introduce the remarks made and inferences deducted therefrom:

"*The geological position of lead ore* appears to be in the palæozoic rocks. The ore of New York, and the vast quantities which exist in the Western States are in these rocks: and in his able report of exploration in the great lead region of Iowa, &c., made by order of the Secretary of the Treasury of the United States, Mr. D. D. Owen has shown that the formations containing the lead ore are the equivalents of those which, in the north of England and in Scotland, have been considered the richest lead country in the world. But if, as is not impossible, many of the so-called primary rocks of Vermont are metamorphic palæozoic rocks, may we not then hope to find workable veins of lead in these rocks? Mr. Owen has given us an answer to this inquiry:

"'It behooves us to remember that the metalliferous capacity of rocks depends rather upon their lithological character than upon their precise age. Phillips, in a recent geological treatise justly remarks: 'It is not because of any peculiar chemical quality that limestone yields most lead ore on Aldstone Moor, but because it is a rock *that has retained openness of fissure*. Gritstones, in many mining fields near Aldstone Moor, are equally productive; but shales * * have closed up their fissures, and their crumbling faces appear to have rejected the crystallizations, which have attached to the harder limestone, grindstone, and chert.'

"In this connection we cannot forbear mentioning the remark made to us by a practical miner, who was expressing his belief that there was no workable ore in the Chittenden mine,—'that the rock there was so hard that the lead could not grow in it.' As is often the case with practical men, the fact was correct, although the theory of growth was such as we cannot subscribe to. The English geologist quoted by Mr. Owen has exactly expressed the idea of the miner so far as relates to the fact. But Mr. Owen further remarks: "'All other things being equal, the older the rock, or in other words, the nearer it approaches the inferior igneous rocks (the presumed sources of metallic ores), the greater is the probability of its being rich in metals.'

"And if so, should not metamorphic rocks, being so much nearer the sources of igneous agency than the palæozoic rocks, contain greater quantities of lead? The usual fact that they do not, is not inconsistent with the general theory stated by Mr. Owen, for as the ores of zinc and lead are quite easily volatilized, they may have been sublimated out of those rocks which have been subjected to powerful metamorphic agency, while others less intensely heated have received and retained them. If extensive veins and deposits of lead once existed in Vermont, we should therefore expect now to find only some small vestiges remaining. In this view of the subject, we see the ground of the remark before quoted, that 'The metalliferous capacity of rocks depends rather upon their lithological character than upon their precise age.'

"Nevertheless it must be admitted that some valuable lead mines exist in metamorphic and even in igneous rocks, where perhaps the igneous agency was not continued so long as in other cases, or where other circumstances may have prevented the escape of this ore. It is therefore not probable but possible, that galena exists in the State in workable quantity."

SILVER.

Notwithstanding the many reports of silver mines that reached our ears during the progress of the Survey, we have never been able to learn the *precise* locality of even one workable mine of silver in the State. We did, however, find several excavations made

*See pp. 227–8.

where *supposed* treasures were located, either in the form of silver ore, coined metal, or both. A case of the latter kind occurs in Wallingford in what are called the "white rocks," a precipitous range of quartz rock, situated about two miles east of North Wallingford village. At intervals, for the last twenty years, companies of men have assembled here and worked laboriously in this hard rock, for weeks at a time, with the vain hope of finding a "cave which some Spaniards had made in these rocks, long time ago, by the removal of ore, and in which they had subsequently worked and reduced the ore to metal, and coined this into "Spanish dollars."

The story, briefly told, is about like this: When Richard Lawrence, of Chester, now an old man, was a boy, he did a slight favor to an aged stranger who was traveling through the town upon horseback; whereupon he was told by the old man that for the kindness shown he should some day be richly paid. He informed the youth that he was a Spaniard, and that the saddle-bags upon his horse were filled with silver dollars that he had recently obtained from a cave in Wallingford. Many years before, when he was a boy, he and other Spaniards had come to this country, and discovered, in a mountain in Wallingford, a rich silver mine, which they had worked for a long time and very successfully. In order to keep the thing a secret, they had taken the precaution to smelt the ore and coin the metal, in the cavity made by the removal of the ore in the mountain. The mouth of the adit leading to this cavern was known to but few, and strict secrecy was enjoined.

After having worked several years, and "made money enough," the party resolved to return to their native country. But here they were in a dilemma: They had an immense amount of money made, but no means at hand to carry it home with them, nor was it possible for them to secure means for the transport of all of it. Pack horses were obtained, and bags full of the treasure were taken off and carried to Spain; yet large lots of silver in bars, and an immense amount of coined metal was left in the cavern, either to remain there forever, or be taken by any of the party who should ever stand in need of any more money than that taken by them at this time.

Years rolled by, and this old Spaniard was the only survivor of that fortunate band of adventurers who had worked in the silver mine of Wallingford. He had left Spain to get another dividend from that treasury, and when young Lawrence met him he was upon his journey home, laden with the shining treasure. He was so favorably impressed with the prepossessing appearance of young Lawrence, that he finally concluded to unburden his heart, and, for the first time in his life, communicate to mortal man where this great treasure lay,—with the condition that the young man should not tell of it while it was probable that the old Spaniard should live; but *after his having a reasonable time to die*, the contents of the cave were all to be at Lawrence's disposal.

True to his trust, Lawrence did not communicate this intelligence to any one for many years, but finally told it confidentially to a few friends, and went to find the cavern. But alas! the adit leading to this subterranean storehouse of treasure could not be found.

After diligent search and fruitless attempts to find the opening in the side of the mountain of rock, it was concluded that the door had been closed by some great slide of the rock from points further up the mountain. "Mineral rods" were procured, and a man found who could *work* (?) them, after which the location of the cave was pointed out.

To reach it was a difficult task; but the immense wealth in store there would make all rich, and pay the expense of blasting to it, even if starting at the top of the mountain.

Money was raised, powder purchased, men employed, and the work of reaching the cave by blasting out the solid rock that lay above it was commenced and continued for several weeks, but finally abandoned for a time. Again and yet again the work has been resumed and abandoned. At times the mining party has consisted of more than a dozen men, who have vigorously pushed the work for weeks at a time. But, notwithstanding all these efforts, the hidden treasure is still unreached, and we are not permitted to record the discovery of that lost cave, or the remnant of that rich lode of silver.

We have given the foregoing account as we received it from those who owned "stock" in the mine. We give it not for sport, or to wound the feelings of any who engaged in the wild scheme, but merely as one of the many hundreds of similar examples where people are lured on and induced to dig for hidden treasures where there is no reasonable ground for supposing they have an existence.

Before closing our remarks upon silver, it may be well to say that it is usually found associated with the ores of lead that are found in metamorphic rocks, and that in the lead from Thetford traces of silver were found by Prof. Olmsted, who subjected the ore to an analysis.

T. Sterry Hunt, Esq., Chemist of the Vermont Geological Survey under Prof. Adams, tested some of the lead ore from Morristown, for silver, and the following is his report:

"*Galena.* Morristown. A portion of lead reduced from this ore, gave a small quantity of silver by cupellation. It was equal to one-fifth of one per centum, which is four pounds of silver to the ton (2,000 lbs.) of metal. This quantity will be well worth working, provided the lead is abundant. An assay on another portion of ore, embracing fragments from several specimens to afford an average, will be very desirable, as the general proportion of silver may be greater or less than that afforded by the specimen examined. Probably one pound of silver in a ton of lead would more than repay the cost of extraction, as lead yielding only four ounces to the ton is said to be profitably cupelled in Great Britain."

In the analysis of galena from Chittenden no silver was found, and even should all the lead veins of Vermont prove argentiferous, the probability is that not one of them could be profitably worked for silver.

GOLD.

Gold is not found in a state of ore, but occasionally is alloyed with silver and other metals, and always occurs in a metallic state. Its rich yellow color, its great specific gravity, its malleability and ductility, and its insolubility in any single acid, will distinguish gold from other metals. It is rarely found in crystalline forms, but more usually occurs in thin plates, or in irregular-shaped grains varying in size from specks invisible to the naked eye to nuggets of several pounds weight. It never predominates so as to form veins by itself, but is associated with various mineral substances in which it is often impasted as quartz, rhomb spar, pyrites, &c.

In the undecomposed sulphurets, gold is never detected with the eye, but in the oxyd resulting from the decomposition of pyrites it is often perceptible, and occurs in feathery threads and minute grains.

The first gold found in the State, of which we have any knowledge, was a large lump in Newfane, in the year 1826. It was found in the valley of West River, in the western part of the town. Its weight was eight and one-half ounces, and its value was about $125. A portion of this nugget was for several years exhibited in the Cabinet of General Martin Field, of Fayetteville, who believed it to be native gold.

We are not aware that its discovery created much excitement, or was followed by any feverish mania for gold-hunting in the vicinity. The fears of those who would object to the influx of gold hunters from abroad, and the attendant demoralizing influences, were quieted in the belief that the nugget was not indigenous, but had been brought from abroad and dropped there. The idea then prevalent with many, that gold and the precious metals were found only in countries where the climate was warmer than that of Vermont, gave plausibility to this theory, and the only obstacle then presented was, who dropped it? Capt. Kidd, for two reasons, was evidently clear from any participation in this business; first, it was too far inland for him to venture to hide his treasures there; and secondly, he never hid his money so that it could be found. It was therefore suggested by those who were not aware of the fact that the gold-bearing rocks extend the entire length of the State, that probably some rogue or counterfeiter had dropped it.

The fact that "a family of Wheelers," who were suspected of making and passing counterfeit money, lived near where the gold was found, gave some plausibility to the theory; but there were good grounds for supposing that they never had the nugget in their possession: First, they were too poor to purchase a nugget of that value; secondly they were never even suspected of passing or making spurious *gold* coin, and therefore would have no use for it; and thirdly they never claimed that they lost it. But what at first was mere suspicion became a "fixed fact" in the minds of many intelligent men in Newfane and vicinity, and hence it was reported that there was little or no doubt the Wheelers dropped it. In the First Geological Report of Prof. Adams (page 32) we find the following: "A specimen of gold weighing several ounces, was lost in Newfane many years since, by a gang of counterfeiters when suddenly routed, as is now supposed by those who are best acquainted with the facts; and having been subsequently found, it has been quoted as an example of the native gold of Vermont."

The gold of the Southern States and Mexico, being found in the talcose slate formation, it occurred to the reflecting minds of Prof. Eaton, of Troy, N. Y., and Prof. Hitchcock, of Amherst, Mass., that it might also be found in the talcose slate of Vermont; hence in 1833, Prof. Hitchcock, while prosecuting the Geological Survey of Massachusetts, visited Somerset, Vt., and found gold deposited in the drift of that town, and describes it at length in his First Report to the Legislature of the State of Massachusetts, pp. 65–66, and the following is the conclusion at which he arrived. After stating the circumstance of seeing it washed out, and having with the aid of his knife "picked two or three pieces from the dirt," he adds: "Upon the whole it appears to me that the facts above stated justify the conclusion that there exists a gold region in the lower part of Vermont, of considerable extent and richness."

Comparatively little was then known of the Geology of the State, but Prof. Hitchcock and a few other geologists had become satisfied of the existence of the gold-bearing talcose schist, and equally well satisfied that gold was also to be found within its borders.

This however was not the prevalent opinion in the community, and many, entertaining the preconceived delusion that the occurrence of gold depends upon the climate, rather than upon the rock formation of a country, were disposed to look with distrust upon the assertion that gold existed in Somerset, and considered its occurrence a trick played off by the owner of the land, who had placed the gold there "for the purposes of speculation." *

In the summer of 1851, Matthew Kennedy, Esq. discovered gold in a gangue of quartz that traversed the talcose slate of Bridgewater. He did not disclose the fact, however, till he had secured a title to the land in September, 1852. Upon examination, it was found that gold existed in three or four distinct veins of quartz, within the space of eighty rods; whereupon the "yellow fever" broke out in the community, and raged with unabated fury till a sale of the property was made to Ira F. Payson, Charles J. Kane, and Simeon M. Johnson, in 1853. This company erected a crushing mill and placed in it an engine for working the "crushers," "stampers," "washers," &c., and in June, 1854, made the first experiment of separating the gold from its matrix of quartz.

Various reports were afloat in the community respecting the amount of gold obtained per week from the quartz, but nothing reliable was ever known to "outsiders" of the per centage of gold which the quartz yielded. Amid the conflicting reports it was, however, evident that the "stock" of the company was on the decline; and the result was, that in February, 1855, the works were suspended and abandoned by the proprietors, and the property again fell into the hands of Mr. Kennedy, by virtue of a mortgage which he held on the premises.

Since 1855 the mines have not been worked; but, as the property has been purchased the present season (1859) by Abraham Taggart, Esq., a returned Californian, of New Hampshire, who is well acquainted with all the improved processes of crushing and separating the gold from quartz, it is highly probable that the work of extracting the gold will be again resumed.

That gold exists in the quartz of Bridgewater, the recorded testimony of hundreds who have visited the mines, as well as the exhibition of the specimens taken from thence, fully attest; but whether it occurs in quantities that will warrant an outlay of capital sufficient to carry on the work advantageously, is, in our opinion, a question that can only be settled by experiment, for as yet we conceive that no satisfactory test has been made. The needless expenditure, and the loose and extravagant manner in which the work of the former company was managed, are, in our opinion, sufficient in themselves to account for the suspension of the labor in 1855.

The auriferous quartz veins vary in thickness from a few inches to several feet, and in them are found specimens of the sulphurets of copper, lead and zinc, with occasional crystals of automolite. In the most western gangue numerous cavities occur in which is found a yellow oxyd,† very closely resembling that taken from the "rich pockets" of the celebrated McCullock gold mine of North Carolina. Good specimens of gold in the auriferous quartz, also specimens of galena, blende, &c., were obtained and are now in the State Cabinet in Montpelier.

* Prof. Adams' First Annual Report of Geology of Vermont, p. 32.

† E. L. Goodale, of Saco, Me. analyzed this bog ore, and found a large per cent. of gold in it.— C. H. H.

During the year 1855, several, who had worked in California, struck with the similarity of the rock formations, and encouraged by the occurrence of gold in Bridgewater, commenced the work of "prospecting" in Vermont, and generally were able to "raise a color," and in some instances lumps of considerable size were found. During that season about $700 worth was obtained from all the "diggings" in Vermont, of which about $500 were from the town of Plymouth. Dams were built, sluices were erected, and for a while there was a prospect that the "gold fever" would rage to an alarming extent in that town, so noted for the good health and industrious habits of its yeomanry. But upon the whole, gold-hunting did not prove profitable that season, and during the two following years little or no gold washing was done in that town. The purity of the gold obtained in Plymouth, exceeds that generally found in California, as will be seen from the following, which is a copy of a certificate issued to one who sent his "pile" to New York, in order to determine its value and purity.

"Assay of gold from Plymouth, Vt:

Weight before melting, ...	136 dwts.
Weight after melting, ...	133 dwts.
Carats fine, ...	23¼
Value per dwt.	.9955
Total value, ...	$132,40

(Signed) PLATT & BROTHERS, Assayers, No. 4, Liberty Place.

New York, Nov. 9, 1855."

In other parts of the State during the years 1856–57, "prospecting" was done and gold found in several places, as at Stowe, Worcester, Granville, &c., &c., but not in sufficient quantities to divert the mind of the farmer or mechanic from their usual pursuits, and induce them to commence washing for it with the hope of becoming suddenly rich.

In the fall of 1858, William Hankerson, Esq.— a returned Californian, who had discovered the gold in Plymouth, in 1855— returned to that town, after having prospected in many places in Vermont, New Hampshire and Maine, and commenced digging with a fair prospect of success. He secured a claim at the "Five Corners," and in digging over a space less than two rods square, and not averaging five feet in depth, extracted therefrom over $400 worth of gold. Cold weather approached and he was compelled to abandon his work, but in the spring of 1859 he resumed his labors and worked in a systematic manner.

As the course taken by Mr. Hankerson is the one adopted by most of those who work successfully at washing, and as it may be interesting to those who have not seen the operation, we propose to give a brief account of the manner in which the gold is separated from the gravel, pebbles, and disintegrated rocks, among which it is disseminated:

From a pond at the upper end of his claim Mr. Hankerson took out water in a sluice, and having conducted it over a water wheel to which was attached machinery for working the pumps to drain the mines, he caused it to pass through sluices into which the earth containing the gold was thrown. The sluices, made of sound boards were from fifteen to twenty inches wide, and from six to ten inches deep, and elevated at the upper end sufficiently to induce the swiftness of the water to wash off all the fine and lighter material, and leave the pebbles and gold at the bottom.

It was the work of one man to stand at the sluice with a long-toothed iron rake, and with it to take out all the larger pebbles; and by a continual stirring the smaller ones, with the dirt, were carried down the sluice and escaped at its outlet. In the bottom of the sluice there were placed "riffles," which consisted of a framework that could be removed at pleasure — being made of slats of wood about one inch square and long enough to reach across the sluice. These slats were about two inches apart, and on the top of them were nailed strips of sheet iron about one and three-fourths inch wide, and as long as the wooden slat, thus giving a space of about one-fourth of an inch between them. In the cavities beneath the sheet iron, and between the wooden cleats, the sand and small pebbles soon accumulated, but upon the approach of a particle of gold some of the lighter materials in the cavities were at once displaced, in consequence of the greater specific gravity of the gold which became permanently lodged there.

After "washing" in the sluice about a day's time, the water was shut off, and the "riffles" taken out, and all the sand, gold, and other material lodged there was carefully taken and run through the "rocker," which was a machine somewhat resembling a cradle, with a screen to take out the coarser pebbles, and with slanting shelves, over which the water and mud containing the gold were made to pass, in order to rid the precious metal of the lighter and worthless material with which it was associated.

After passing through the rocker the residue is taken and "panned out," which consisted in taking a pan, not unlike a common milk-pan, and after putting in the material to be washed, the pan is immersed and water made to pass over the edge into it, by which the muddy portion becomes stirred and suspended in the water, and is by a peculiar shaking motion emptied out, while the gold and heavier material remains at the bottom. This part of the operation requires some experience and tact, in order to do the work quickly and not lose the gold. It is in "panning" that the "black sand" shows itself most abundantly, for, owing to its great weight, it is the last substance to be washed out, and when the gold is in fine grains it is no easy task to separate it from the sand.

"Black sand" is usually an ore of iron — titanic, magnetic, and specular oxyds — that occurs in the form of octahedral crystals of small size, or in irregular grains varying in size from a fine comminuted particle to pieces as large as a kernel of corn. These being disseminated through the soil, are collected together by their great weight where gold is washed, and not unfrequently small pieces of lead (shot and bullets) are found, if washing is done upon what has been a hunting ground.

Thus far it is evident that much the largest amount of gold from any one town has been found in Plymouth. But even in this town it is difficult to determine the exact amount obtained, for the statements of those who dig are influenced by surrounding circumstances. For example, those who have a poor claim, and wish to dispose of it, give a flattering account of their success; and probably claims may have been "salted"—that is, gold placed in the earth to be subsequently washed out—to tickle the fancy of those who might wish to purchase a claim. In one case it is reported that California gold was used to "salt" with; but that attempt at deception was too bare-faced to succeed, for the color of California gold is so unlike that of Plymouth, that at first glance an experienced eye would readily detect the imposture.

In other cases where the claims were yielding a good income, the workmen were often silent as to the amount they were getting. In one case where there was a dispute about the title of a claim, the two men who were working it complained of "hard work and poor pay;" but when the title was secured to them beyond a doubt, they showed their "pile," which was worth two thousand dollars, the result of about three months labor for each of them.

To attempt to arrive at accuracy in the amount obtained in all the "diggings" in town were a difficult task; but, from the most reliable sources through which information could be obtained, it is probable that between seven and eight thousand dollars were obtained during the season of 1859. As to the question whether it was profitable to a majority of those who worked, we will give it as our opinion that not one in ten who have engaged in gold washing in that town has realized as much from it as he would have done by working on a farm at the ordinary wages paid for labor to those who work by the month; and from the best estimates that we are able to make from the data in our possession, we are of opinion that if the whole amount of gold washed in Plymouth during the year 1859 were put together, and from it were deducted the expense of erecting dams, sluices, water wheels, pumps, and other incidental expenses connected with the work, the remainder, if divided among all who washed for gold, would not amount to fifty cents per day to the hand.

Many engaged in washing for gold in Plymouth who were not only inexperienced in gold washing, but even in hard labor, and in such cases the efforts were unsuccessful. Others, used to hard labor, engaged in digging without making suitable preparations, by erecting pumps to be worked by water; and the result was, that upon removing the gravel and reaching the "bed-rock"—where was found most of the gold—the water from the stream would rush in so as to require one or two men constantly at the pumps in order to keep the pit dry enough to work in; and during the night the water would fill it so much as to require a half day's hard labor to pump it out. Therefore, under these circumstances but comparatively little time could be devoted to shoveling the auriferous gravel into the sluices; hence, a correspondingly small income was realized, even in places which, under suitable management, would have yielded a rich reward to those who labored.

Thus far gold has been washed only from the gravel in or near the bed of streams of water, but it is highly probable that Plymouth and other portions of the State will furnish "dry diggings"—that is, deposits of gold at considerable distance from the beds of existing streams—in "old river beds," through which no water now runs, but which were worn down at remote periods of time by streams that now wind their way through other valleys, or through other portions of the same valley in which living streams are now found. The gold of Vermont, with the exception of that found in the auriferous quartz of Bridgewater, has been found generally in the "unmodified drift" of river valleys. Sometimes it is found at the surface of recently deposited gravel, and continues the entire distance to the "bed-rock;" but usually the gold, and especially the coarser kinds, is found on or near the bed-rock at the bottom of the valley. By "bed-rock" is meant the solid rock upon which the gravel, bowlders, and other loose material, are situated.

In many cases, upon reaching the bed-rock, rich deposits of gold are found immediately under gravel, in which scarce a trace of it exists. Gold deposits in Vermont are confined to certain rocks, and it will now be our business to describe the general character, position and extent of

THE GOLD-BEARING ROCKS OF VERMONT.

From examinations made, it is evident that the auriferous belt extends the entire length of the State, and has a width equal to that of the so-called talcose slate formation.

Talcose slate is a stratified rock of a greenish color, having smooth lamina of a pearly luster, and, when reduced to powder, it is unctuous to the touch. In some specimens, and especially where gold is found, the slate is of a dark color, the surfaces often tarnished with the oxyd of iron, and upon splitting open the weathered specimens they have a shining black or dark lead color. In this dark variety of the talcose slate small angular cavities are common, in which there doubtless once existed cubic crystals of iron pyrites, which, upon exposure, have become decomposed and formed the rusty tarnish upon the surface of the slate. Concretionary masses and veins of quartz of a porous, granular variety are also abundant in the slate. This quartz, like the slate, has a rusty appearance, and contains cavities which not unfrequently are filled with an oxyd of iron; and, in the more compact portions, crystals of iron pyrites are met with, some in a perfect state of preservation, and others partially decomposed.

The fact that rocks like those above described are usually found in the vicinity of gold deposits, and the strong resemblance which they have to some of the auriferous ochres of the gold mines of North Carolina, induced us to examine carefully the ochre found in the cavities of quartz, for gold. After several unsuccessful efforts, we at last succeeded in finding gold in the ochre from a cavity in quartz, which was conclusive evidence that the gold thus found was originally associated with the sulphuret of iron. But gold in Vermont is sometimes found in small flattened masses between the lamina of slate, and in one specimen found in Plymouth, by Dr. J. Green, we noticed the gold traversing the slate in feathery veins, crossing the lamina at various angles; and again in numerous cases it is found in quartz, entirely free from any sulphuret or foreign matter, and in the larger nuggets found there are almost invariably small subcrystalline masses of quartz disseminated through or adhering to it. This occurrence is so common, that miners usually regard the occurrence of quartz veins in the talcose slate as a sure indication of the existence of gold in the gravel overlying and in the vicinity of it.

But the result of the observations which we have made in various portions of the State induces the belief that the occurrence of gold is more common and more abundant in the vicinity of the black talcose slate, which is sometimes called plumbaginous slate, and which is usually found the best developed near the serpentine and soapstone beds that occur at intervals nearly the entire length of the State. In every case where we have made an examination for gold in deep valleys east of the soapstone or serpentine beds of the talcose slate, we have found it to exist, and think there is not an exception to this in the State. In suggesting this opinion to a successful and intelligent miner, and one who has "prospected" in New England more extensively than any other man,— Mr. Hankerson,—in answer to our inquiries, said, that he did not think he ever washed a dollar's worth of gold five miles east or west of the line of serpentine and soapstone beds, or five dollars' worth one mile east or west of them. In these beds there is

usually a great abundance of rhomb or bitter spar, which, upon decomposition, leaves a deposit of the oxyd of iron, in which there is found gold in very fine grains; hence, it would appear that it enters into the composition of the spar that is associated with the soapstone and serpentine of Vermont.

From the foregoing it is evident that gold is not confined to one rock, but is found associated with quartz, soapstone, and talcose slate, and the pyrites and spar that are associated with them. Nor is gold scattered indiscriminately among all the rocks of the State; for it is not found in the granite, gneiss, mica schist, or clay slates, but is confined to the so-called talcose schist formation.

Talcose schist extends over a large portion of the State, and it is evident that the occurrence of gold is equally extensive.

The first belt of talcose slate is a narrow one, and extends up the valley of the Connecticut River from Rockingham to Essex County. We are not aware that gold has been found in that vicinity, still we strongly suspect its existence there.

The second and most extensive development of it is found on the eastern side of the Green Mountains, and extends the entire length of the State. In the northern part the mountains are mainly composed of talcose schist, and it is highly probable that the "gold fever" will, at some future time, rage with fury in some of those deep eroded valleys so abundant in Northern Vermont.

In Western Vermont the hill and mountain tops are formed of talcose or talcoid schist, that rests upon limestone or marble, and in the valleys gold is not unfrequently found. Perhaps some who wash for gold, and find it upon limestone or gneiss, may think the foregoing conclusions, restricting gold to the talcose slate formations, erroneous; but in reply it may be said, that, although gold in the south-western portion of the State may be found in the crevices of limestone or marble in the valleys, yet it was once doubtless imbedded in a matrix of talcose slate, which, being worn down during the vast cycles of time since it was deposited, the gold became disengaged, and, by its great weight was retained in the valley beneath and near its original place of deposit.

In other cases, upon the eastern side of the Green Mountains, gold is found in the gravel reposing upon a bed of gneiss; but it is usually in very fine particles, or "scale gold," and was doubtless transported thither by water from its parent bed in the talcose schist, west of where it is now found.

That gold is scattered over extensive districts in the State, and will be found in other places than those now known to contain the precious metal, is very evident; and it is not at all improbable that other nuggets may be found, equaling in size and value the one found in Newfane.

The largest lump found in Plymouth was valued at fourteen dollars, and was found in Reading Pond Brook, on the claim of Messrs. Sawyer & Eddy; and the largest one found at the Five Corners was valued at nine dollars and thirty cents, and was from the claim of Wm. Hankerson, Esq.

[During the years 1860-61, gold washing has been carried on successfully, and at times quite extensively, in the town of Plymouth; and, in 1860, the prediction made in the foregoing report, that gold existed in the narrow belt of talcose schist along the Connecticut, was verified by its discovery in the eastern part of Springfield. For awhile there was considerable talk of the Springfield gold, and allusions to it were oftentimes made in the newspapers; but we think that nothing has been done at gold washing in town during this year (1861), and that the inducements are not such as to warrant success in the enterprise. The work in Plymouth has been steadily carried on during the two last years by men who were acquainted with the business, and the average yield of gold is much greater than that of 1859. During the present season work has been carried on in dry diggings, with results that were very gratifying. These dry diggings are, at present, confined to the sides of the valleys of Buffalo, Reading Pond, and Gold Brooks, but will, doubtless, be found in other valleys of this town, and ultimately extend along the line of gold deposits, to towns in other portions of the State.]

COPPER.

Copper is a metal of a reddish-brown color, possessing a strong metallic taste and smell when placed in the mouth or rubbed in the hand. It was well known and extensively worked by the ancients, and derived its name from the island *Cyprus* where valuable mines of it were worked. It occurs in nature both metallic and in a state of ore. One of the best localities for native copper, is in the vicinity of Lake Superior. Here the copper is found in extensive veins, from which immense quantities of the native metal are obtained.

But the ores from which most of the copper of commerce is obtained are the sulphurets and carbonates. The sulphuret—which is the most valuable copper ore found in England and Vermont—has a metallic luster, and is of a yellow color that passes into a copper red or an irised blue or purple, and occasionally assumes a greenish hue.

The carbonates of copper usually have various shades of green and blue, oftentimes arranged in concentric bands that present a pleasing appearance upon being smoothed and polished across the grain. Malachite is the name usually applied to such specimens.

Copper is found in several places in Vermont, in some of which are such quantities as to warrant the working of the beds or veins. There appear to be two divisions or lines of deposit, one in the eastern and one in the middle portion of the State.

In Richford*—a town bordering upon Canada—indications of copper are quite abundant, and are evidently allied to, and a continuation of the Canada copper mines, among which are those of Acton. On a line nearly corresponding with the direction of the strata, and between Richford and Acton, are numerous indications of copper ore, and at Sutton (Canada) excavations have been made with very gratifying results.

Theodore W. Smith, Esq., of St. Albans, Vt., the proprietor of land upon which copper ore is found in Sutton, having been informed that a vein (or bed) of ore was upon his farm, commenced making excavations in the rock in the fall of 1860, to test the question whether or not workable ore existed there. In compliance with his invitation, we visited the locality soon after the work was commenced. We found in the rock (talcose schist), for the distance of twenty rods, the irised sulphuret of copper disseminated through the rock, in a line with the foliation (or stratification) of the rock, having a direction nearly north and south. At the surface, particles of ore, varying in size from a mere speck to pieces the size of a hazel nut, were quite common; and, in several cases, the gangue containing the ore was a foot in thickness, and extended in length several feet.

In one of the excavations made, we noticed the gangue at the depth of six feet from the surface was about three feet in thickness, while at the surface it was not more than one.—

*We are informed that copper ore is now (October, 1861) being found in considerable quantity in Richford by those mining for it.

The ore, too, was more abundant in the lower portion of the vein exposed than at the surface. The vein-stone consisted of quartz, talc, feldspar and limestone irregularly mixed together and blended with, and forming a matrix for the ore. The outcrop of rock containing the ore is upon a hill, north and south of which were valleys in which was no exposure of rock. Drift striæ were very abundant in the vicinity, and the valleys are doubtless the result of drift or glacial agency, hence we deemed it highly probable that should ore exist in workable quantities in that vicinity, it would be found in the valleys, for by the decomposition of the sulphurets, and their rapid disintegration, the work of erosion would be much facilitated; hence we advised that trenches be dug in the valleys across the slate in a line with the outcrop on the hill, with the hope that ore would be found upon reaching the bed-rock.

[Since the manuscript, relating to copper, was placed in the hands of the printer, Mr. Smith has informed us that he is still continuing his explorations, and has sunk a shaft upon the lode to the depth of sixty feet, from which he has obtained and sent to market thirteen tons of ore, and has on hand about fifteen tons which will yield twelve per cent. of copper. In descending with the shaft, the lode was found to contract and expand—in some places having a thickness of five feet, in other places narrowed to two or three feet, and in one place nearly disappeared, but soon returned again, and at the bottom of the shaft has a thickness of four feet.

A horizontal adit is now (Oct. 1861) being driven along the line of the lode, with a view of testing its extent. In descending with the shaft a curious phenomenon was observed: The copper ore—which at the surface was of the irised variety—upon penetrating the lode with the shaft was found suddenly to change in one spot to an orange color or the yellow sulphuret. Upon removing the ore it was found that the portion of the lode running north from near the center of the shaft was the yellow variety, while that running south from the same point was the blue or violet-colored ore, the line of junction happening at a point near the center of the shaft. The line of demarcation was easily seen for the distance of ten feet in depth, when it disappeared and there was a return of the irised ore, which continues to the bottom of the shaft. The ore is disseminated in small granular masses through the rock, and requires dressing, or "cobbing," before being sent to market.

A sample of the undressed ore was sent to Dr. Hayes, of Boston, for analysis, which elicited the following result, as shown by his certificate as State Assayer:

"State Assayer's Office, 16 Boylston St., Boston.

"Result of assay: Sample of copper ore received from Mr. Theodore W. Smith contains four and four-tenths per cent. copper.

(Signed) A. A. HAYES, M.D., State Assayer."

Oct. 21, 1861.

In a note to Mr. Smith, he adds:

"* * * The sample represents undressed ore, and not simply ore, as most of the mass was rock. This is as much per cent. as the English ores yield *as raised* where richest, but they are dressed or washed to a higher grade.

Very truly yours,

A. A. HAYES."]

The outcrops of copper in Richford and Waterbury have not been fully developed by mining, but it is not improbable that mines in those towns may become sources of wealth from the amount of copper obtained therefrom. Nor is it at all unreasonable to suppose that copper may exist in workable quantities in towns between those named, as in Montgomery, Johnson, Morristown, Stowe, &c.

Copper pyrites is the ore found in the beds of Eastern Vermont. It has a metallic yellow color of a deeper hue than that of the sulphuret of iron, and is not so hard a mineral. The two are usually associated together in beds or veins.

The beds of copper in the eastern portion of the State occur in the calciferous mica schist formation, and are found at intervals, extending from Holland—a town bordering upon Canada—to Strafford, a distance of about eighty miles in a right line.

In Holland, traces of the yellow sulphuret of copper are found in connection with iron pyrites, but no attempt has been made to work a mine in that town for copper.

The next locality of copper to be noticed occurs in Brighton, on Kilby Creek, a branch of Clyde River, about three miles from Island Pond village, on land of Harvey Coe, Esq. The bed (or vein) has a direction bearing a little east of north, and in several places has considerable thickness. Experiments have been made to determine the extent of the outcrop of ore, but nothing like systematic mining has been carried on. Iron pyrites are quite abundant, and, in connection with it, is found the copper ore. The outcrop indicating the presence of copper extends fifty rods or more, and is upon the north-eastern slope of a hill, thus affording an opportunity to drive adits in at considerable depths below the surface. Its proximity to the railroad would much enhance its value, should it prove a rich mine, containing an abundance of copper ore.

The copper mines of Corinth were visited by the Geological Corps in 1846, and specimens of ore were obtained that were subjected to analysis by Prof. Olmsted, with the following results:

Copper,	27.28
Iron,	37.91
Sulphur,	33.70
Silica and mica,	1.11
	100.00

These mines are situated two and one-half miles west of the village, upon elevated land, and are favorably situated for mining purposes.

CORINTH COPPER MINE.

From A. S. Little, Esq., we are informed that the first discovery of copper ore was made in that town by Mr. Ira Towle, and the first attempt to work it was made by Mr. Barber, of New York, who made several excavations on the bed, and obtained considerable ore from the surface; but the encouragements were not sufficient to induce a great investment of capital, and the lease which he had was suffered to expire.

In 1854 the "Corinth Copper Company" commenced their labors upon the bed, and continued the explorations commenced by Mr. Barber. After having worked the mine about two years, the company became satisfied of the impracticability of working the surface layer for ore, and it was again abandoned. From this surface work, which has been unprofitable to all engaged in it thus far, the truth of the existence of an immense amount of valuable copper ore has become well established. Capt. Pollard, the superintendent of the Vershire mine, whose opinion in such matters is highly valued, thinks the indications for a valuable bed at Pike Hill are fully equal to those seen at Vershire. Copper pyrites are known to exist for the distance of about one-fourth of a mile, and the deposit is probably more extensive even than that.

But experience has established the fact that the only way to work copper lodes with profit, is to sink shafts and drive horizontal adits; and when sufficient capital is invested and judiciously applied by men of experience and good judgment, there is little doubt that the Corinth mines will prove very valuable. The bed of copper is conformable with the gneissoid mica slate incasing it, and has a strike N. 10° E., and dips about 45° E.

VERSHIRE COPPER MINE.

The next copper mine to be noticed is one situated in the town of Vershire, about two miles from West Fairlee village, and ten miles from the railroad station in Thetford, and now worked by the "Vermont Copper Mining Company."

The discovery of copper ore at this place was made about forty years ago. The decomposing sulphurets of iron and copper at the surface, and the unusual appearance of the earth that overlay the ore, excited the curiosity of people in the vicinity, and gave rise to reports that smothering fires, fireballs, smoke, &c. were seen there and induced them to make excavations to learn the cause. Upon reaching the bed-rock, iron and copper pyrites were found, the former quite abundant; and, in accordance with the adage of the Cornish miners, that "Mundic* always rides a good horse," people were led to believe that valuable copper ore existed in that hill. Accordingly, a company was formed, consisting mostly of people who resided in the neighborhood—with the view of working the mine—which was styled the "Farmers' Company." Excavations were made on the vein, and iron and copper pyrites obtained, when a rude smelting furnace was erected. But, in consequence of the inexperience of those having the business in charge, little or no copper was ever obtained from the ore smelted.

Col. Binney, of Boston, and Isaac Tyson, Esq., of Baltimore, Md., were the next to engage in the enterprise of working the mine. The outcrop of rock containing the ore being upon the southern slope of a hill, and about four hundred feet above the valley adjacent, they very wisely concluded that the only proper way for working a copper mine, thus situated, was to drive in an adit so as to strike the bed at considerable distance below the outcrop at the surface; hence, they at once commenced the work of driving a cross-cut adit, and pushed it vigorously for more than two years. Having penetrated the rock horizontally ninety-four feet, and not striking the ore or bed, they became discouraged, and the work was abandoned.

In 1853, some gentlemen of New York city purchased the mines and two hundred and forty-eight acres of land adjacent. In the fall of that year, a charter was granted by the Legislature of Vermont, constituting them a body corporate, under the name of the Vermont Copper Mining Company, with a capital of five hundred thousand dollars. In the spring of 1854, the work was systematically commenced under the superintendence of Captain Thomas Pollard, an intelligent and experienced Cornish miner, since which time the work has been continued under his supervision and attended with the most gratifying results. The cross-cut adit abandoned by Messrs. Binney & Tyson was, at once, entered

*Mundic is an impure sulphuret of iron, usually found with copper pyrites.

by the workmen and driven in the direction of the ore, and they had not proceeded four feet before it was reached! The bed was found to consist of copper pyrites associated with mundic, and was from eight to sixteen feet in thickness, and had a dip of about 42° E.

Indications of ore exist at the surface of the ground, for the distance of about one-fourth of a mile, in a line with the strata of the rock. It occurs in the calcareous mica schist, which assumes a gneissoid appearance in the vicinity of the mines. These are situated on the southern slope of a hill, and the drifts or adits are, with the exception of the cross-cut adit before named, all in or near the line of the ore, and represented by the following cuts (Figs. 333 and 334), which exhibit a vertical and horizontal section of the mine.

Fig. 333.

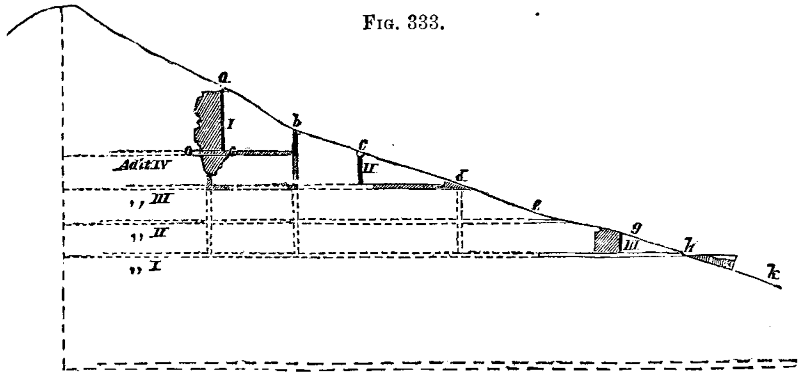


Fig. 334.

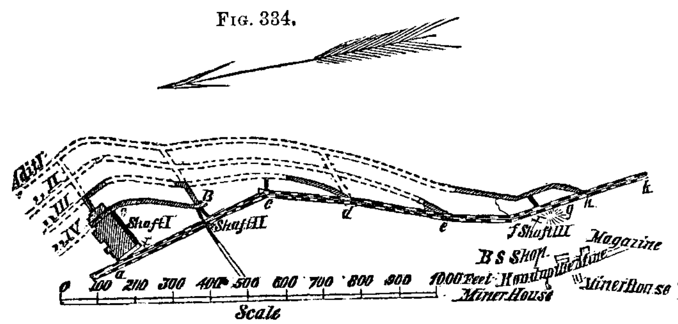


Fig. 333 exhibits a vertical section of the mine. The letters *a*, *b*, *c*, *d*, represent the points where shafts are sunk, or are to be sunk. The dark vertical lines show where shafts are now sunk—the dotted lines those contemplated. The dotted horizontal lines show where adits are to be driven, and the shaded lines were intended to show the extent to which each had been worked; but since obtaining the draught from which the cut (Fig. 333) was made, the third adit, as we are now informed (Oct. 1861) by Hon. S. Thomas, has been driven entirely through from *d*, so as to intersect the shaft descending from *a*. The length of this adit is 778 feet and the depth of the shaft *a* is 315 feet. The average thickness of the bed along the third adit, from *d* to the bottom of the shaft *a*, is about twelve feet.

Fig. 334 exhibits a horizontal section of the mine. In consequence of the eastern dip of the bed the lower adits extend further east than those above, as shown in the cut. The adits are identical, and the letters refer to the same thing in both cuts. The dark line *a*, *k*, represents the course of the outcrop of the ore—being made crooked by the irregularities of the surface upon the hill-side.

The ore, as before stated, occurs in a continuous bed, conformable with the schist inclosing it, and has an average thickness of about twelve feet. But little veinstone is seen, and the ore occurs nearly independent of rock or other impurities, except the sulphuret of iron, and occasional veins or concretionary masses of quartz. In descending into the earth, the bed is found to change in appearance and improve in quality. At and near the surface, "gossan" is found overlying the mundic and copper ore, but upon reaching the solid bed or vein, the mundic thins out and the pure ore is more abundant. The sulphuret obtained at this mine yields about thirty per cent. of copper—when pure ore is subjected to analysis—but the ore sent to market yields on an average about nine or ten

per cent. This reduction results from the impurities associated with it, as silex, iron, sulphur, &c.

Shipments of ore from this mine have been made that yielded seventeen per cent., but it is usually considered better not to "dress" or "cob" the ore, so as to have it yield more than ten per cent., as much good ore is lost in the refuse thrown away, and the additional labor required to separate the ore from the waste is much increased. It is sold in the ore to smelting companies, who use it in connection with the carbonates and other rich copper ores; and serves so valuable a purpose for a flux, that up to this time it has been thought more profitable to sell it in that state, than incur the additional expense of erecting smelting furnaces and smelting it separately. It occurs to us, however, that it might now be well to erect a furnace, and smelt at least a portion of the ore near the mines, for there would not only be a great saving in freight, but also much labor saved that is now required to "dress" and properly prepare for market the lighter ores. Again, there is on hand in huge piles, near the mines, ore of an inferior quality that would probably pay well for smelting, which is now considered nearly valueless. It has also occurred to us, that if the ore before being sent to market were roasted, and the sulphur expelled, that there would be a material saving of expense in freight, to say nothing of the difference of cost in the fuel used in the process of roasting.

In order to save what is valuable in the inferior ores, the company have erected buildings, in which they crush, wash and prepare the ore for market. The *crusher* is worked by a stationary steam engine of twenty-five horse power, in a building thirty by fifty feet, which adjoins another building sixty by eighty feet, in which the ore is cobbed, washed and packed for market.

The business of this company has steadily increased from year to year, as will be seen from the following account of sales, as shown by the books of the company, to which we had access through the kindness of Capt. Pollard:

In	1854 there were raised and sold	134 tons.
	1855	198
	1856	137
	1857	246
	1858	314
	1859	788½
	1860	1312
and they had on hand, unsold,	1860	140

These footings were made up to Nov. 1st, of each year. During the months of November and December, 1860, the amount raised and shipped was not far from four hundred tons.

Facilities will soon be afforded for raising four hundred tons per month, or more. Adits have been driven, and shafts sunk around and through the bed, revealing a mass of ore which, if successfully wrought for twenty-five years, with the present force, cannot be exhausted.

The shaded portions of the cut, at the shaft *a* and near the small shaft *g* (Fig. 333), show where the ore has been removed by all who have worked the mine. The present company have sold more than three thousand tons, obtained from the shaded portion of the cut (which is the reduced copy of a map, constructed from an accurate survey made of the mine), and when this small portion is compared to the area embraced in the cut from *a* to *h*, and extending far below the lowest adit, some idea of the extent of the ore will be obtained. Even the ore cut off from the bed by the third adit and the shaft *a* is enormous, as one will perceive by multiplying the length, 778 feet, by one half the height, 157 feet, and that product by the thickness of the bed, say 12 feet.

How much may exist in the hill further north, or the depth to which the bed extends, can only be reached by conjecture, but the inference is that the quantity is inexhaustible. The "prospect" to us, seems to be far more flattering than that which was presented in most of the valuable copper mines in the world, at the commencement of their being wrought. Generally, in opening copper mines a lavish expenditure is required before there is any return of the money invested, and oftentimes years roll round before there are any profits realized.

In the Wheal Fortune lode of the *consolidated mines* of Gwenap, in Cornwall, England, mundic and other material were removed to the depth of four hundred and eighty feet below sea level before any copper ore was reached, considered worth dressing. The vein was eight feet in thickness, and proved to be one of the most valuable copper mines ever worked. It afterwards produced one hundred tons per diem, which yielded six per cent. of copper. The ore sent to market from Vershire has a greater per centage of copper than that sent from the Cornwall mines,—the former yielding, on an average, nine to ten per cent., while that from the Cornish mines usually yields about six or seven per cent. of copper.

During the year 1859, about three hundred tons of the ore were sent to England and smelted, but at present (1861) most of the ore is smelted at East Boston, and at Bergen Port, New Jersey. The greatest depth in the bed which has been reached is three hundred and fifteen feet, making a perpendicular depth of about two hundred feet below the surface.

The company employ one hundred hands, exclusive of those engaged in taking the ore from the works to the railroad station. They are employed as follows: twenty-five are miners, seven strikers, six trammers,* two blacksmiths, two carpenters, two masons, three teamsters, two head dressers,† and fifty one spaders, cobbers,‡ &c.

STRAFFORD COPPER MINE.

The next bed of copper to which attention will be called, is situated in the south-east corner of Strafford, and by referring to the Geological Map it will be seen that the three beds of copper found at Corinth, Vershire and Strafford, are nearly in a right line with each other, and it is found also that they are nearly in range with the *strike* of the rock, or the direction of the strata, in that portion of the State. It is also a noticeable fact, that the rock is the same along this line; and contiguous to the copper the mica schist assumes a gneissoid appearance, in which there are found hornblende, quartz veins and occasional crystals of feldspar.

*Men employed in running the "trams" or ore wagons, on the tramway or railroad track along the adits.

† Overseers, or those who take charge of the dressing or cobbing.

‡ Persons employed in breaking the ore into small pieces and separating the good ore from the waste.

The copper ore at Strafford occurs in copperas ore, or sulphuret of iron, and is found in *pockets* instead of being continuous, as at Vershire. This mine was discovered in 1793, and several years worked for copperas ore. Upon penetrating the bed, copper ore was found in small veins and in concretionary masses or "pockets" in such quantities as to induce the proprietors of the copperas works, associated with Isaac Tyson, Esq., to commence the work of smelting the ore for copper. For nine years the work was continued, but not upon a large scale, or in such a manner as to result in profit to the proprietors. In 1839 the enterprise was abandoned.

Upon penetrating the bed at greater depth, by the removal of the sulphuret of iron for the manufacture of copperas, valuable copper ore was found to exist, and in such quantities as to induce the proprietors to again resume the copper mining business. A new smelting furnace was erected, about three-quarters of a mile from the mine, which is still used, upon a small stream capable of driving the machinery required at a blast furnace.—About seventy-five men are now employed in the various pursuits of mining, teaming, smelting, &c.

An adit is being driven into the hill in the direction of the ore bed, with the expectation of striking it at the depth of about two hundred feet below the surface, where it is hoped there will be found copper ore more abundant and of a better quality than that heretofore found at this place. Experience has proved that copper mines improve in quality as they extend deep into the earth. Hence the experiment was made of driving in this adit. The maximum thickness of the bed of iron and copper pyrites where it has been worked is seventy feet, and its average is not far from forty feet.

The outcrop of ore is upon the eastern slope of a hill, and it has a dip and strike conformable with the strata of the wall-rock. At the surface the dip is about 50° E., but at the end of the adit near the ore bed and about two hundred feet below the surface, the rock has a dip of 74° E. From the fact of this curving of the strata, the bed at the depth of two hundred feet may be "pinched out" and the ore at that place may not be abundant; but a shaft sunk in the bed, or an adit driven either north or south on the bed, would doubtless reveal comparatively rich lodes of copper ore.

The process of reducing the ore to pig copper will be briefly given: After being raised from the mine it is *cobbed*—that is, reduced to pieces of the size of a hen's egg and smaller, for the double purpose of separating it from iron pyrites and other foreign impurities, and also that it may be the more easily calcined and fused than if left in larger lumps. It is then placed upon layers of wood, in piles similar in appearance to coal-pits, each containing from twenty-five to forty tons of ore. The wood is ignited, the fire of which, with the semi-spontaneous combustion of the ore, keeps up a heat for about twelve weeks, during which the ore becomes "roasted" and the sulphur is mostly expelled.

If desired, much of the disengaged sulphur could be secured by sublimation, but the low price at which it is sold would hardly warrant the undertaking. Sulphur is not unfrequently found incrusting portions of the piles of ore, or running in streams down the sides. At times, the heat produced by the burning sulphur is so great as to partially fuse the ore, in which case it is necessary that it be again reduced to small pieces before being taken again to the furnace.

Instead of having the metallic-yellow hue, the ore, after it has parted with its sulphur, becomes oxydized, and assumes a black, earthy color, in which state it is put into a cold-blast furnace, in the proportion of four tons of ore to one ton of anthracite coal. The intense heat of the furnace soon fuses the ore, and the metal is received through an orifice into the "steep," a basin made in a mixture of charcoal and clay, in front of the furnace. This is called the "first metal," and quite closely resembles the slag from an iron furnace, but not in the least resembling metallic copper. This first metal is then sorted, the worthless portions being thrown away, while that containing copper is again broken up and "roasted" in ovens prepared for the purpose, to expel the remaining traces of sulphur. This roasted metal is then again taken to the furnace and smelted, and produces what is called the "second metal," which has a metallic luster, but not that of pure copper.

The process of roasting and smelting is repeated several times before the whole is reduced to a state of purity required for pig copper, suitable for market. No fluxes are required for reducing this ore except what are contained in it. The slag of the metal is used as a flux for the ore, and the slag of the ore is used as a flux for the metal.

The processes to which the ore is subjected before the pure metal is produced are many and varied, and require men of large experience to do the work successfully. One having witnessed the operations would listen with incredulity to the legendary tales told of the "old Indian," who used to find ore in the mountains, and at a single heat obtain copper with which he purchased his powder, whiskey, &c. There are produced at the furnace about five tons of pig copper per month, for which there is a ready market found in Boston.

This embraces a notice of the copper mines which have been worked in the State; but we cannot refrain from placing the abandoned bed of "copperas ore," near Cuttingsville, in Shrewsbury, among the localities where copper ore exists. We are not aware that copper was ever found in connection with the iron pyrites, but the surroundings give evidence of its existence in this locality. The position of the bed more closely resembles that of the Cornish mines than any other in the State; for here are found the granite (*growan*) upon which occurs the metamorphic schists, with the outcrop of mundic near the points of their junction. It is in places near the junction of granite and the greenish clay slate (*killas*) that the copper lodes are the richest in the mines of Cornwall.

The sulphuret of iron at Cuttingsville occurs in a bed, in many places twenty feet thick, apparently interstratified with the adjacent rock, which has a strike N. 70° E., with a general dip of 30° S.E. The rock under the bed is gneiss, with a sprinkling of hornblende in its composition. The rock overlying the ore is an impure limestone, containing concretionary patches of calcareous spar, somewhat resembling imperfect fossils. Near the south-west end of the outcrop of ore there is a hornblende dike, extending five rods in a line with the ore, and separates it from the overlying rock. The whole length of the bed exposed to the view is about one-fourth of a mile. The strata containing the ore, as well as the bed itself, are curved, so that in some places they are nearly horizontal, but there is a conformability existing the entire length of the outcrop; hence, we unhesitatingly call it a bed and not a vein of ore.

From the foregoing it will be seen that copper is found quite abundantly in the State; and we are of opinion that, when fully developed, the copper mines will prove much more remunerative to the proprietors than those of any other metal ever worked in Vermont.

Native copper has been found, in small pieces, at Strafford and Vershire, but not in quantities sufficient to warrant the expectation of its occurrence in workable quantity in the vicinity of these mines.

In Dog River, in Northfield, a piece of native copper was picked up a few years since which weighed a pound or more. When first informed of the fact, we were inclined to the opinion that it had been recently placed there—either accidentally dropped or had been thrown from the cars that frequently pass this place, laden with native copper from the Lake Superior mines. But upon examination of the lump we became fully convinced that it had long been detached from its parent bed, for by attrition it had been worn quite smooth; and possibly this, like the huge "Ontonagon lump," may be the fragment of a rich deposit of native copper not very far from the place where it was found.

MINERAL SPRINGS.

The salubrity of the air and the purity of the water of Vermont, are generally classed among the beneficent blessings with which the people of the State are favored. No springs of purer water or of greater extent, and no streams more limpid, are anywhere found than those of Vermont, and especially in the middle and eastern portions of the State.

Notwithstanding the almost universal purity of the water, there are in the State several springs so strongly impregnated with sulphur, iron, magnesia, carbonic acid, and other ingredients, as to render them valuable for medicinal purposes. But few of the springs in the State have gained great celebrity abroad, and the visitors to them are not so numerous as those resorting to the acidulous or carbonated springs at Saratoga, but the number of those sojourning at the watering places in Vermont is annually increasing. Clarendon, Highgate, Alburgh, Williamstown, and Newbury, are fast becoming the resort of those in quest of health or pleasure during the warm weather of summer.

Sulphurous or sulphureted springs are the most abundant, and may generally be known by the sulphurous odor emitted by their waters; and when strongly charged with sulphureted hydrogen gas, the water will blacken a solution of sugar of lead, or give a black tarnish to silver immersed in it. In some cases the evolution of sulphureted hydrogen gas is so abundant and of such purity as to readily burn when collected and brought in contact with a flame. Sulphurous springs are not restricted to any particular rock formation, but seem indiscriminately scattered in different portions of the State.

The opinion expressed by many that the sulphurous springs originate in strata near the surface, and are the results flowing from decomposed iron pyrites, seems to be without good foundation, for the legitimate result of such decomposition is the sulphate of iron or green vitriol. But such products are very rarely obtained in the analysis of the water.

The origin of sulphurous springs, like that of volcanoes, is not definitely settled, but both are evidently the results obtained by some deep-seated, powerful and widely extended agency.

The water of sulphurous springs usually deposits an ochery substance generally resembling iron rust or the oxyd of iron. These are known by different names, as "Powder

Springs"—from the resemblance the odor has to that of burnt powder; "Iron Springs" or "Iron Rust Springs"—from the ochery deposit made by the waters; "Burning Springs"—from the inflammable nature of the gas that often arises from them, &c.

The peculiarities of the water having been given, a few of the most prominent springs in the State will be noticed.

NEWBURY SPRINGS.

A few rods north of the pleasant and thriving village of Newbury, on land of Hon. Joseph Atkinson, is a spring, which has gained considerable notoriety for its medicinal properties, and is becoming the resort of many in search of health or amusement. Excellent hotels, the Female Collegiate Institute, the refined state of society, the beautiful and varied scenery upon every side—conspire, with the medicinal springs, to make Newbury one of the favorite resorts for persons from abroad, who sojourn in our State during the summer.

Wonderful cures are reported as resulting from the use of the spring water at this place, and we doubt not salutary effects and perhaps permanent cures are effected by their use in cutaneous and urinary diseases. The water is evidently charged with a large quantity of sulphureted hydrogen gas, which gives it the peculiar odor it contains. Its taste is not offensive, but when a small pinch of common salt is put into a tumbler full of it, and dissolved before drinking, there is a decided improvement; and it so closely resembles the famous Blue Lick Water of Kentucky, that good judges are not able to detect the difference.

Very little effort has been made by the proprietor to give publicity to the springs, and the celebrity which they have gained are mainly due to the efficacy of the water, and the efforts of others to bring them into notice.

An analysis of one quart of this water was made by Dr. J. R. Dix, with the following result:

	grains.
Sulphate of Iron,	12.15
Sulphate of Lime,	3.30
Sulphate of Soda,	4.28
Chloride of Magnesia,	8.50
Carbonate of Iron,	11.26

[For the following articles on Alburgh and Highgate Springs we are indebted to George F. Houghton, Esq., of St. Albans, Vt., a gentleman who was assistant State Naturalist under the late Hon. Augustus Young, and who has been a firm friend of the Geological Survey from its commencement, and to whom we are greatly indebted for many favors received.—A. D. H.]

ALBURGH SPRINGS.

BY GEORGE F. HOUGHTON, ST. ALBANS, VT.

The long-established reputation of Alburgh Spring water, as a medicinal agent, justifies more than a passing notice in this Report. Alburgh Springs have been a place of resort since 1816—public attention having been drawn to them thus early by the late Benjamin Chandler, M.D., of St. Albans, as being very efficacious in the cure of all forms of cutaneous and scrofulous disease. The number of visitors to these springs has since gradually increased from year to year. At first, boarding-houses were used for the accommodation of visitors. Timothy Sowles, Stephen Sweet and Elisha Reynolds (all farmers), were induced at an early day to accommodate visitors during the summer months, and occasionally during the winter.

In 1834, the "Mansion House" hotel was built by Benajah S. Phelps, of Alburgh, and Horace Wadsworth, then of North Hero and now of Grand Isle; which hotel Mr. Phelps first occupied and then was succeeded by the late Samuel Mills, of Burlington,—subsequently by Francis W. Stoughton, the late Frederick Hazen, Calvin Harvey, Benjamin Allen, Billings Carpenter, Thomas Donaldson, and Chauncey Smith the present occupant. The "Mansion House" is a spacious hotel fronting to the east and north, with a frontage of eighty feet on two streets, and a piazza to two stories, and is built for the comfortable accommodation of nearly one hundred guests.

The efficacy of the medicinal waters of Alburgh becoming better established from year to year, and the number of visitors—as well for health as pleasure—constantly increasing, another public house was thought to be demanded for the accommodation of the public. In 1854 a new and commodious hotel was erected by Azem Niles, Charles P. Harvey and Haviland L. Sweet, and opened in the spring of 1855 by Niles and Harvey. This hotel is called the "Missisquoi House," and is also calculated for the convenience of nearly one hundred guests. It is one hundred and twenty-four feet in length and forty feet in width, with three stories, and two piazzas to two stories. It has been occupied by Messrs. O. Porter Carpenter, Thomas Carpenter, and now (1861) by Merrit I. Manzer and Charles P. Harvey.

From the "Missisquoi House," as well as the "Mansion House," carriages runs to and from the passenger trains on the Vermont and Canada Railroad, for the accommodation of travelers during the summer.

There are two springs. The northern one is about four rods distant from the main spring, and the water is somewhat more ferruginous in its character, and well adapted for the cure of liver complaints. The main spring is nearly equidistant from the Mansion House and Missisquoi House, nearly thirty rods from each, and accessible by side walks from both. Both springs are eighty rods from the western shore of Missisquoi Bay, and nearly thirty feet above the level of Lake Champlain at high water mark. Both of the springs are furnished with a carefully prepared tube, and are constantly used, and the northern spring has been largely used for bathing purposes. They are situated less than one mile and a half from the Alburgh Springs station, on the Vermont and Canada Railroad, six miles from Clarenceville, Canada, eight miles from Philipsburgh and Highgate Springs, and eighteen miles from St. Albans.

These springs are resorted to by pleasure seekers, as well as invalids, who come periodically, armed with gun, fishing-rod and tackle, to enjoy the sports of fishing, hunting, and rowing on the bay. Light sail-boats are in requisition to supply the popular demand for such sports when the lake is open. Aside from this, a new academy and two new churches have been recently added to the other attractions of Alburgh Springs.

These springs rise from an argillo-calcareous slate, and the water is of a milky appearance, and is very strongly impregnated with hydro-sulphuric acid. The scientific analysis of this water—which has been made by Thomas Sterry Hunt, Esq., the chemist and mineralogist to the Provincial Survey of Canada, with the greatest care and skill—will be found at length in a subsequent part of this Report.

Similar springs are found in other parts of Grand Isle County. One lies west of the court-house in North Hero, near Back Bay, or Pilot's Bay; and in South Hero there are two springs nearly equal in strength to Alburgh Springs. One is on lands owned by Benajah Phelps, and one on the farm of John Landon. Both are resorted to more or less for their waters, by man and beast. There are, also, in the town of Grand Isle, wells which are strongly impregnated with hydro-sulphuric acid—one very much so—near Reuben Sampson's, on land owned by Mr. McGowan. Quadrupeds are very fond of the water, but fish die instantly when put into it.

Within a few miles of Alburgh, at Pike River, in the Seignoiry of Sabrevois, Canada, are springs similar in character to Alburgh springs; and about two miles south of Henryville is another spring, whose water resembles that of Alburgh, and is quite sulphurous and has a somewhat sweetish saline taste. They are all obviously in the same geological position, and, in the absence of any qualitative analysis, may possess the same mineral ingredients.*

HIGHGATE SPRINGS.

BY GEO. F. HOUGHTON.

The mineral spring to which the name of Highgate Springs was given, is situated in the western part of the town of Highgate, in Franklin County, twenty rods east of the highway leading from Swanton to Philipsburgh, on land now owned and occupied by Mr. George Averill. They were not known or resorted to until several years after Alburgh Springs had become a place of public resort. Stephen S. Keyes, Esq., of Highgate Falls village, then the owner of the land on which the springs are located, was in the habit of sending to Alburgh for a supply of spring water, until he was informed by John Averill, Esq., in the year 1820, that there was a mineral spring upon his farm. This information induced a thorough examination by Messrs. Keyes and Averill. They excavated the earth to the black slate rock, whence the water flowed. In removing the earth, a large quantity of deer and moose horns and bones were thrown out. The spring was familiarly called a deer lick, from the fact of its waters being resorted to by cattle of all sorts. After it was dug out and put in a condition suitable for use, a strong fence was indispensable to prevent the access of cattle which had been familiar with the water and greatly attached to it.

After the rocks had been blown out, Mr. Averill put a tube into the spring, and made it convenient for public use. A few small boarding-houses, in the immediate vicinity of the spring, were opened soon after its discovery, by Thomas Webster and other farmers in the neighborhood; and so frequent were the visits of invalids to the springs for the use of the water in the cure of scrofulous, cutaneous, rheumatic and liver complaints, that in 1840 Stephen S. Keyes, Esq., then the owner of the large and fertile farm on which the springs were located, was induced to erect—for the comfortable accommodation of

*Vide Geological Survey of Canada. Report of Progress for the year 1848–49, pp. 58—60.

visitors for health or pleasure—the large and convenient hotel called the "Franklin House," with the surrounding houses for bathing and bowling purposes. This hotel is beautifully located in a thickly wooded grove, about a quarter of a mile from the eastern shore of Missisquoi Bay, and twenty-five rods from the mineral spring. It possesses ample accommodations for sixty boarders, and has always been well kept for the entertainment of guests. It was first occupied by William Wood, of Georgia, afterwards by P. A. Durfee and Charles A. Cutting, under the firm of Durfee & Cutting; by Messrs. Harvey N. Cole, Jeptha Bradley, Wm. Hunter, Cha's Sandford, C. C. P. Gould, Hubbard S. Barlow, Franklin N. Johnson, Charles Taylor, and by its present occupant Mr. George Averill, the son of the gentleman who first discovered it. In October, 1857, Stephen S. Keyes, Esq. sold the Franklin House, and thirteen acres adjoining it, to Mr. George Averill, who is the present owner and occupant.

Excellent sporting and fishing grounds are within a few rods of the "Franklin House," and the hunting and fishing attractions of Highgate Springs, together with the comforts of a first-class hotel, annually draw many pleasure travelers from all parts of the United States and Canada. The "Franklin House" is situated three miles and a half from the Swanton station, on the Vermont and Canada Railroad, and thirteen miles from St. Albans. Carriages are in attendance on the arrival of each passenger train, to convey passengers to Highgate Springs during the summer months. This delightful summer retreat owes its celebrity to its mineral waters, and justifies the detailed narrative which has been given.

A qualitative analysis of the water—which has been made in the most thorough manner by Thomas Sterry Hunt, Esq., of Montreal, the chemist and mineralogist to the Provincial Geological Survey of Canada—which can be found in a subsequent part of this Report, indicates the difference between the ingredients of Highgate and Alburgh Springs.

BRUNSWICK MINERAL SPRINGS.

These mineral springs are situated about one and one-half miles from North Stratford Depot, N. H. (Coos P. O.), upon the Grand Trunk Railroad, in the town of Brunswick, Vt., near the western bank of the Connecticut.

There are at this place several springs issuing from the ground, and it is found that they each possess different qualities, but are all chalybeate. Little attention has been given to them, except by persons residing in the immediate vicinity, as no hotel accommodations have been afforded. But the efficacy of the water in curing cutaneous diseases is so well established now, that measures are about being taken to erect a hotel; and, being so near the great line of thoroughfare between Montreal and Portland, it will, with judicious management, doubtless become a favorite resort for those in quest of health or pleasure. A. J. Congden, Esq., of Lancaster, N. H., has recently purchased the springs and considerable land adjacent, with the view of fitting up extensive accommodations for visitors. The amount of water is not found to vary in quantity in wet or dry seasons, but runs in large and uniform quantity the entire year. In the heat of summer the water is very cold, but in the cold weather of winter it never freezes, which is conclusive evidence that its source is not near the surface, but is deep-seated in the earth.

CHESTER MEDICINAL SPRING.

This spring is situated about one-half mile above the south village on land of H. E. Emery, Esq. It was first discovered in 1860, and visited by the writer in 1861. It issues from the steep western bank of Williams River, about fifty feet above and six rods distant from the stream.

From the odor of the water, it is evident that sulphureted hydrogen gas is abundantly disseminated in it, and the ferruginous deposit attests the fact of its being a chalybeate spring. The surprising cures effected by the waters of this spring are not yet published, but from the well beaten footpath leading from the highway to the spring, made during the present season, and the company assembled with jugs to take off the water, at the time of our visit, were convincing proofs that the water had already gained great celebrity in the vicinity, considering the short time that had elapsed since its discovery.

No analysis has yet been made, and little has been done to render the waters noted, or the place attractive. With the unsurpassed facilities presented for erecting bathing-houses, we trust another season will not pass before they are built; for oftentimes bathing is found more efficacious in cases of salt-rheum, inflamed eyes and other kindred disorders, than any other mode of using the water.

MARTIN'S SPRING.

In the north part of Shaftsbury, near the saw mill of Mr. Simeon Martin, is found a mineral spring from which is evolved sulphureted hydrogen gas, and the water deposits an ochre that reveals its chalybeate character. The spring is resorted to only by persons residing in the vicinity. The water is found to possess qualities beneficial in the cure of cutaneous eruptions. Nothing is done by the proprietor to bring the water into notice, and it is but little used.

WARREN SPRINGS.

Far up the mountain, in the eastern part of Warren, are several springs of a singular nature and which we suspect to be medicinal. The water is nearly or quite inodorous, but from it are deposited large quantities of the oxyds of iron and manganese (?). This sediment, which strongly resembles umber in appearance, forms a crust of considerable depth for quite a distance, and at one of the springs there is an accumulation similar in shape to tufaceous crust that forms High Rock Spring at Saratoga. Cattle resort to this spring for drink and are gradually wearing down the ochery hillock, from the top of which the water issues.

Sulphureted springs are found one mile south of West Randolph, on land of Dennis Green; two miles west of Tunbridge village, on land of John Cowdry; near Hartland Four Corners; also, at Hartland Depot; in the eastern part of Arlington; in Andover, Chelsea, and probably in many other towns in the calciferous mica schist formation.

Some years since an effort was made to bring water from a spring far up the western slope of the Green Mountains into Danby Borough (we think this was the place), through a metallic pipe; but, as might have been expected, the disengaged sediment in the water became attracted by the metal of the pipe, and was permanently lodged in it; and in a short time the pipe became completely filled with this sedimentary deposit, so that it was impossible for any water to pass. We name this circumstance that others may *not* "go and do likewise."

We are of opinion that in nearly all the sulphur springs of the State the sulphureted hydrogen gas is merely held in solution by the water, and evolved upon coming in contact with the air. When this is the case the water does not long retain the gas, and soon becomes inodorous. But where there is a union with some basis, forming a hydro-sulphate, the sulphureted character of the water will be retained even after it has been boiled. By this test the character of the water in this respect may be determined.

In conclusion, we will add, for the benefit of those who may dislike the taste of water from sulphur springs, that it may generally be greatly improved by adding a small portion of common salt before drinking, as suggested in our remarks upon Newbury Springs.

MAGNESIAN OR PETRIFYING SPRINGS.

Springs are also found depositing calcareous tufa*, and from this it is evident that lime and magnesia exist in the water. These springs too seem to be restricted to no particular locality or rock formation, being extensively distributed, but are most generally found in the vicinity of magnesian limestones. From this circumstance—partaking as the water does of the nature of the rock from which it exudes—the inference seems plausible, that however deep may be their origin the mineral contents are derived from the rocks through which they run and from which they escape.

Tufaceous deposits are not only found at Clarendon, Williamstown and Hartford, in the vicinity of springs where the water is known to possess medicinal properties, but are also found in other places, and especially in the western parts of Rutland and Addison Counties, in the vicinity of Lake Champlain. In many places along the shore of the lake, the rocks are incrusted with tufa, and in some cases extensive beds of conglomerate are formed, with pebbles, imbedded in a matrix of travertine.

From this it is evident that magnesian springs have existed, or do exist, in the vicinity of these deposits, and without doubt the waters when found and properly tested, will prove medicinal.

CLARENDON SPRINGS.

These Springs were doubtless among the first ever visited for their medicinal virtues, and are probably more resorted to than any others in the State.

Tradition informs us that their medicinal character was first discovered in 1776 by one Asa Smith, who resided in the eastern part of the town. He is reported to have "dreamed" of a spring in the western part of the town, and, full of faith, started through the wilderness and over the high hill that separates the two portions of the town, in search of the spring that would furnish water that should restore him to health. Arriving at this spot, he recognized it as the one he had seen in his dream, and accordingly at once drank of the water, and bound clay saturated with it upon his swollen and inflamed limbs. The scrofulous humor, which for years had been a source of continual annoyance,

*Calcareous tufa or travertine, is a light-brown or yellowish-white substance, consisting principally of lime and magnesia deposited by water containing these substances. It is this substance that forms the curious rock at "High Rock Spring" in Saratoga.

at once yielded to the potent influence of the water, and the man was soon restored to perfect health. We do not vouch for the truth of this marvelous tale, but tell it as it was told to us.

The springs have for many years been considered highly efficacious in the cure of bilious complaints, dyspepsia and all cutaneous disorders, and are steadily growing into popular favor. From fifteen to twenty-five hundred persons annually visit them in quest of health or pleasure, and while the invalid is restored to health through the agency of the medicinal properties contained in the water, and the business man's mind rendered elastic by having removed from it an undue weight of care and anxiety, the pleasure seeker can find a full share of enjoyment in the beautiful scenery, the pleasant drives, the numerous brooks for trout-fishing, the interesting surroundings and excellent home afforded at Clarendon Springs.

Spacious hotel accommodations are afforded to such as choose to sojourn there, and stages daily run from the springs to West Rutland, which is about six miles distant.

Calcareous tufa was formerly found abundantly in the vicinity of the springs, which gives evidence that they are of a magnesian character.

From an analysis by A. A. Hayes, of Boston, one gallon, or two hundred and thirty-five cubic inches of the water is found to contain:

Carbonic acid gas,	46.16 cubic inches.
Nitrogen gas,	9.63 cubic inches.
Carbonate of lime,	3.02 grains.
Muriate of lime, Sulphate of soda, Sulphate of magnesia (Epsom Salts),	2.74

One hundred cubic inches of the gas which was evolved from the water consists of

Carbonic acid gas,	.05 cubic inches.
Oxygen gas,	1.50 cubic inches.
Nitrogen gas,	98.45 cubic inches.

From the above, it is evident that the medicinal properties of the water result more from the gaseous than from the mineral contents. This is true of a majority of the medicinal springs in the State.

The water evidently issues from a fissure that extends from the springs some distance south, and described heretofore as a line of fracture from which the rocks of Clarendon and Tinmouth dip east and west. Most mineral springs are supposed to exude from deep fissures or faults that exist in the subjacent rocks. Saratoga Springs are doubtless located near an extensive fault, for it is found that the calciferous sandrock is upon the west of the springs while the Hudson River shales come to the surface upon the east. The Clarendon Springs issue from the silicious and magnesian limestones that lie a short distance below the marble beds of the Eolian limestone formation, and it is doubtless from these rocks that the medicinal properties contained in the water are obtained.

WILLIAMSTOWN SPRINGS.

In a deep gorge called the Gulf, through which the stage road from Montpelier to Royalton passes, in the southern part of Williamstown, there are medicinal springs

which are becoming noted, not only for their curative properties but also in consequence of the romantic scenery that surrounds them. A steep-sided ravine, having a width in many places only sufficient for the road to pass along, extends two miles in length, presenting on either side high rocky walls with occasional spots where the outline is not so sharp pointed, but the hills recede and give greater width to the valley. In one of these expansions of the valley is found the Gulf Spring of Williamstown.

Here, too, is found a nice hotel erected for the accommodation of guests, with the usual appurtenances of bowling alleys, swings, &c., kept by David Comstock, Esq. These springs occur in the calciferous mica schist formation, and are evidently magnesian, as a tufaceous sediment is deposited by the waters. The water is found efficacious in the removal of cutaneous disorders, dropsy, dyspepsia, sore eyes, &c., and doubtless has properties very similar to the water of Clarendon Springs.

The springs are situated fifteen miles from Montpelier and nineteen miles from Royalton, from which places a stage runs daily.

QUEECHY SPRINGS.

These springs occur in the calciferous mica schist formation, on a beautiful slope of land on the farm of the Hon. Daniel Needham, in Hartford. They are distant from Queechy village about two miles, and from Woodstock seven.

The water is strongly impregnated with muriate of soda and carbonate of lime, and traces of carbonate of soda and muriate of magnesia are easily discernible. It is the opinion of Col. Needham, based upon the judgment of scientific men who have visited the springs, that iodine exists in the water in the state of iodic acid, combined with one of the alkalies.

Large numbers of persons visit the springs, and carry off the water in jugs, demijohns and barrels. Astonishing and rapid cures of salt-rheum, kings-evil, and the numerous variety of scrofulous affections, are told by the visitors.

The water from the springs, as it makes its escape over a grassy bed into a deep basin beyond, has deposited beds of tufa, in some places two or three inches thick. It was by this tufaceous deposit that the springs were first brought to the notice of the public, through the instrumentality of the Windsor County Natural History Society, about the year 1840; since which time they have enjoyed a good degree of celebrity throughout the region of their location.

Some years since, a company was formed for the purpose of laying a pipe from the springs to West Hartford, a village on the Vermont Central Railroad three and one-half miles distant, with the view of erecting a large hotel for the accomodation of guests who might seek the medicinal virtues of the spring water; but the owner refused to sell, although we understand that one thousand dollars were offered for the perpetual right to the water and the privilege of laying a pipe to conduct it.

Although no hotel accommodations are furnished at the springs, the water is cheerfully and gratuitously given to the public by Col. Needham—who always keeps at the springs, ready for the use of visitors, all the utensils necessary to enable parties to use or carry off the water.

ELGIN SPRING.

This spring is situated about three miles south of Vergennes, on land of Solomon Allen, Esq. It is found in the vicinity of magnesian (Chazy) limestone, and, from a qualitative analysis made by C. L. Allen, M.D., it may evidently be classed with Clarendon and Williamstown springs. He found the water to contain

Sulphate of magnesia,	Sulphate of soda,
Sulphate of iron,	Carbonate of lime,
Carbonate of soda,	Carbonic acid gas.

This spring was discovered quite recently, and has not become so noted a place of resort as several other springs in the State; but several guests were present at the time of our visit, who bore testimony to the efficacy of the water in the cure of diseases. As a cathartic, the water is not excelled by any in the State.

A hotel for the accommodation of guests is erected near the springs, and a stage runs daily, during the summer, from the house to Vergennes, to connect with the cars.

This includes, we think, the principal springs of this class, which are much visited for their medicinal properties. There are doubtless many others which have thus far escaped observation.

Near Chelsea village there are large deposits of calcareous tufa which give evidence that springs holding lime or magnesia in suspension once existed, and probably now exist, but are turned from their original course as no spring at present is found discharging its water at this place. Our attention was first called to this subject by Dr. Bagley, of Chelsea, who took a specimen of the tufa and deposited it in the State Collection while this work was going through the press. The writer had not time to visit the locality and report, before the manuscripts would be wanted by the printer, hence we are not prepared to report the existence of a magnesian spring in Chelsea, but strongly suspect one may be found there.

SALT SPRINGS.

In our sister State, New York, brine or salt springs are found and salt water has been reached by boring, which has proved of great value to the commercial interest of the State.

The question may naturally arise whether it may not also be found in Vermont. In one instance a belief in the existence of salt water, that could be reached, was so firmly fixed in the minds of several citizens in Montpelier and vicinity, that a company was formed, with a large capital, in order to test the question by sinking an Artesian well.—On the north bank of the Winooski, near where Main Street bridge crosses the stream, may be seen an orifice in the rock from which it was supposed salt water was to flow; but instead of that there issues a stream of water quite strongly charged with iron, as the sedimentary deposit fully attests.

The company, satisfied of the value that would attach to the discovery of salt water, vigorously pushed their work and penetrated the rock to the depth of about 900 feet, when, despairing of success and having used up the capital stock paid in, the work was

abandoned. We are not informed of the circumstances that induced this lavish expenditure of money, nor do we know who originated the idea of boring there for salt.

The erroneous theory prevails with some, that salt water is always found upon reaching a point as deep in the earth as to be upon a level with tide water. This may have been the cause that led to explorations for salt water at this place. If so, we trust the advocates of that theory will be satisfied of its fallacy, when they are informed that the well was sunk over three hundred and fifty feet below tide water, and no salt water was reached.

A few remarks here upon the occurrence of salt water, may not be inappropriate. We do not propose to discuss the question concerning the origin of rock-salt or brine springs, but have thought it advisable to present a few facts relative to their occurrence, that they may serve as beacons or guides in directing explorations for salt water.

Salt springs and salt wells abound in certain portions of the State of New York, but their occurrence is restricted to a certain sedimentary rock formation, and are never found out of it. Nor are we aware of the existence of salt wells or springs in the United States in rocks essentially differing in age from those in New York—the Onondaga Salt Group.

The oil wells of Pennsylvania are located in rocks below the coal, and nearly corresponding in age with the saline rocks of New York, and the water thrown out or pumped up in connection with the oil from those wells is oftentimes salt.

In the absence of all fossils in our metamorphic rocks, by which their relative age is determined, we are not prepared to say positively that they were not congeners of the Onondaga group; but if so, the agencies requisite to obliterate the fossils and render crystalline the strata, doubtless deprived them of the saline qualities so necessary to sustain salt springs and wells.

In the United States, as before remarked, saline springs are found in the undisturbed palæozoic strata of the upper Silurian and Devonian systems; and it is a noticeable fact in this country and Europe, that gypsum beds are always associated and in close connection with brine springs or deposits of rock salt. An eminent geologist remarks,* that "Deposits of chloride of sodium [common salt] are almost always accompanied with layers and intercalations of gypsum; and the circumstance of two powerful acids, the sulphuric [in the gypsum or sulphate of lime] and the hydrochloric [in the chloride of sodium] being so largely and uniformly present, seems to indicate a common origin."

In England and Ireland, the Triassic and Permian systems furnish the repositories for rock salt, and from them flow the saline springs. But upon the continent of Europe, and in Western Asia, the saline deposits are often found associated with rocks of tertiary age.

There are peculiar markings and phenomena connected with the salt-bearing rocks of New York and elsewhere, which are considered infallible indications of the existence of salt water. These consist in hopper-shaped cavities, which have the appearance that would be produced if salt had existed in them in the form of crystalline masses, and had been weathered out by exposure to water. Other indications, considered reliable, are *sink-holes* and *brine-slips*. But in the absence of all these, coupled with the fact that

*Mantell's Wonders of Geology, p. 542.

salt and salt springs have never been found associated with highly inclined metamorphic strata, it would seem a hazardous enterprise to invest money with the view of finding salt water in the metamorphic schists of Vermont.

In concluding our Report upon the Economical Geology of the State, we will remark, that in consequence of the increased size of this Report beyond what was contemplated,—resulting from the elaborate Reports of the other members of the Geological Corps—we have aimed at brevity, and omitted even the mention of many objects of interest connected with our department.

It has been our intention to present the few facts in our possession in such a manner that all who read shall understand, and hence have eschewed, as far as possible, all technical terms; and, when they have been unavoidably introduced, we have endeavored to elucidate them sufficiently to be understood.

A *Glossary* will be appended to the Report, embracing such scientific terms as may not be familiar to the common reader.

If what we have said in this brief Report shall enlighten the public in relation to the mineral wealth of our State, and the hints thrown out shall induce those in search of mineral wealth to judge more wisely, act more prudently, and be more successful in making explorations, we shall rest satisfied with the result of our labors.

PART X.

PHYSICAL GEOGRAPHY AND SCENERY.

BY ALBERT D. HAGER.

To gratify a desire which has been expressed by many individuals, that a portion of the Geological Report should be devoted to a description of those natural features of Vermont which stand out in scenic beauty, and challenge the admiration of those who behold them, we enter upon the task, giving a brief view of the *Scenographic Geology* of the State. In doing this, we are aware of the effort necessary to depict in an appropriate manner the many and varied objects of interest and beauty, so often met with in Vermont.

Upon the nature of the geological formations of a country depend, in a great measure, the salubrity of the air and its temperature, the purity of the water, the fertility of the soil, and the aspect of its natural scenery. So true is the last proposition, that the geological character of a country may oftentimes be inferred with a good degree of accuracy from a general view of the outlines and surface of its hills and mountains, its plains and valleys.

When hills and mountains are seen to rise abruptly, with mural precipices upon their sides, and capped with angular and naked summits, it is, in general, reasonable to infer that they are either composed of what are usually denominated *igneous rocks*, or of uplifted strata, that have been *metamorphosed* and rendered hard and crystalline through the agency of heat. On the other hand, where the eye in passing over the landscape meets with extensive plains, with nothing to obstruct the vision except wave-like undulations in the surface, it is equally rational to infer that the rocks forming the base are of sedimentary origin, and have not been subjected to the changes attendant upon metamorphism, nor been disturbed by those forces which were exerted in other places in elevating the the hills and extended mountain ranges.

Even the contour of the hills themselves depend, in a great degree, upon the character of the rocks of which they are composed. How marked the contrast existing between the summits of the mountain range composed of crystalline rocks, where quartz or silicious rocks abound, and those composed of argillaceous and calcareous rocks! While the former presents bold escarpments, deep ravines and a rugged surface, with a soil capable of sustaining only a stinted growth of trees and shrubs, and furnishing only second rate pasturage, the latter has a smoothly rounded outline, and, by the disintegration of its own *debris*, has in the lapse of ages formed a soil suited, in a state of nature, to give growth to a luxuriant vegetation, and, under the hand of cultivation, to amply reward the husbandman for his toils; and when viewed by the lover of nature, presents a beautifully interesting panorama, exhibiting in scenic beauty the dwellings and fruitful fields in the valleys, while the flocks and herds are seen sporting upon the verdant hill-sides. We will give a general outline of the natural features of the State, its position and extent, its mountains, streams, and lakes or ponds, and, in proceeding, will call particular attention to a few of the many interesting views and objects which help to form the beautiful and charming scenery for which Vermont is so signally distinguished.

We will not omit, however, to acknowledge our indebtedness for the benefits derived from the writings of the late Prof. Zadock Thompson, and also for the valuable facts and favors received from different individuals, but especially to those artists who have so cheerfully responded to our wishes in furnishing the sketches which are introduced, and present at a glance a glow of associated beauty that our untutored pen would fail to describe. It is to be hoped that the feeble efforts of our pen, and the beautiful sketches that are presented, may awaken in the minds of Vermonters a just pride and appreciation of the beauty and grandeur of their scenery, and induce those who attempt to paint,—whether as finished artists, or a boarding-school miss who is a tyro in the art,—instead of copying some foreign sketch of an old castle or monastery in the Alps or Appenines, to copy from nature in our own country, where the relics of ancient barbarism and superstition do not deface the beauty of the landscape:

"Where breathes no castled lord or cabined slave,
Where thoughts, and hands, and tongues are free."

Vermont is situated between the parallels of 42° 54′ and 45° of north latitude, and between 3° 35′ and 5° 29′ of east longitude from Washington, being about 157½ miles in length, and, on an average, fifty-seven and one-half miles in width, containing 9056¼ square miles, or 5,795,960 acres.

The northern line bordering upon Canada East (which is *nearly* a right line), and the southern one adjacent to Massachusetts are nearly parallel. The eastern boundary line of the State is the west bank of Connecticut River, and pursuing the tortuous course of that stream is about two hundred and fifteen miles in length, and the western boundary for about two-thirds of its length is the middle or deepest channel of Lake Champlain, the remaining part being in a line about twenty miles east of Hudson River.

THE GREEN MOUNTAINS.

The most striking and characteristic feature in the scenery of Vermont is the range of mountains that extends the entire length, and from which the State derives its name.* The Green Mountain range is not confined to Vermont, but extends south through Massachusetts, under the name of Hoosic Mountains, and also far north into Canada East. But in no part of the range are found peaks of such altitude and grandeur as in Vermont.

The general course of the range from the south is north 10° to 15° E., being nearly in a line with the *strike* or direction of the strata of the rocks forming it, and is situated nearly midway between New Hampshire and New York. From the southern boundary of the State to Winooski River, which embraces about two-thirds of the length of the

* *Verd Mont* — Green Mountains.

State, the range is unbroken, and forms a *watershed* from which flow the tributaries of the Connecticut and those of the Hudson River and Lake Champlain.

It is a singular fact that in the northern part of the range, where the highest peaks are found, three rivers — the Winooski, La Moille and Missisquoi — flow through the mountain passes where are afforded good opportunities for roads—not more than five hundred feet above the ocean—while in the southern part of the range no such passes are found, and in order to go from the eastern to the western part of the State, one is obliged to go over the mountain, and not unfrequently roads pass over the range at an altitude of two thousand feet above the ocean.

The pass at Mount Holly, one of the most favorable for a road in the south part of the range, was selected by those who located the Rutland and Burlington Railroad, and is one thousand four hundred and fifteen feet above tide water, while the highest point on the Vermont Central Railroad (at Roxbury) is only nine hundred and ninety-seven feet; and Bolton, at a point between Mansfield Mountain and Camel's Hump, is more than nine hundred feet lower than the "summit" at Mount Holly. The occurrence of these deep transverse valleys in the northern part of the range gives to it the appearance of isolated mountains closely packed together, instead of an unbroken range with elevated peaks, as exhibited in the more southern portions.

The principal peaks belonging to the Green Mountain range, commencing at the north, are Jay Peak, in Westfield and Jay; Lowell Mountain, in Lowell; Sterling Peak, in Cambridge and Morristown; Mansfield Mountain (Nose and Chin), in Underhill and Stowe; Bone Mountain, in Bolton; Camel's Hump, in Duxbury; Potato Hill or Lincoln Mountain, in Lincoln; Bread Loaf, in Ripton; Mount Moosalamoo and Hog Back Mountain, in Goshen; Pico Peak, in Sherburne and Mendon; Killington Peak, in Sherburne; Shrewsbury Peak, in Mendon and Shrewsbury; Saltash Mountain, in Plymouth; White Rocks, in Wallingford; Mount Tabor, in Mount Tabor; Stratton Mountain, in Stratton; Somerset Mountain, in Somerset; Haystack Mountain, in Wilmington; Bald Mountain and Prospect Mountain, in Woodford.

TACONIC MOUNTAINS.

Independent of the Green Mountains, and nearly parallel with them, there is a range extending from Massachusetts as far north as Brandon, known as the Taconic Mountains. In this range are numerous passes, affording an opportunity for roads in the valleys of the Hoosic, Walloomscoik, Battenkill, Pawlet, Poultney and Castleton Rivers. So numerous are these gaps that it gives to the range, especially in the southern part, the appearance of a series of mountains wholly independent of each other. Several peaks in this range rise to the height of three thousand feet or more, and, in consequence of the decomposition of the limestone which often enters largely into the composition of the rock of the mountain, the tops and sides are often clothed with a verdure rarely if ever seen on the western slope of the Green Mountains, where the silicious rocks prevail to such an extent.

The principal peaks of the Taconic range are Bird Mountain and Herrick Mountain, in Ira; Moose Horn Mountain, in Wells; Danby Mountain, in Danby; Eolus (Dorset) Mountain, in Dorset; Master's Mountain, in Rupert; Haystack Mountain, in Pawlet; Bear Mountain and Seymour Peak, in Sandgate; Equinox Mountain, in Manchester;

Minister Hill, in Sandgate; Red Mountain, West Mountain, Bald Mountain and Spruce Peak, in Arlington; Mount Anthony, in Bennington; Petersburg Mountain, in Pownal.

GRANITIC MOUNTAINS.

The third division of mountains to which allusion will be made, is found in Eastern Vermont. The mountains in this part of the State vary from those heretofore named by being disconnected from each other, and form independent uplifts, usually composed mainly of granitic rock. Their form is more usually oval-shaped or conical than otherwise, and the summits are generally formed of conical peaks of granite nearly destitute of vegetation.

The extent and altitude of the mountains in this division are less than in either of the ranges before named. In the north-eastern part of the State, where the greatest number of mountains of this division occur, but comparatively slight examinations have been made, and hence but little is known of their exact character and position. The sides and summits of some granite hills are abrupt and pointed, and others are smoothly rounded, which difference doubtless arises not only from the fact that in the latter case the mountain was more directly exposed to abrasion resulting from *drift* and other eroding agencies, but also from the more ready disintegration of the rock in consequence of the superabundance of potash in the granite in the latter case, while it entered but sparingly into its composition in the former.

We will not close our remarks upon granitic mountains without alluding to one fact which should interest the tourist as well as the man of science. In viewing granitic mountains, either from the east or west, it will be noticed that the peaks are not even-sided, that is, the slopes from the top are not alike. Upon directing attention to them it will be seen that the ascent to the summit from the south is almost invariably steeper than from the opposite side.

In no place is this more apparent than in the granitic hills extending north from Willoughby Lake in Westmore and Brownington. There the most casual observer cannot fail to notice the long, smooth and gradual slope from the summit towards the north, and the abrupt and mural face upon the southern side.

In the Adirondack Mountains, west of Lake Champlain, the same phenomena are observed by one standing east of the lake and looking towards them; but they are not as distinctly marked as in the case first named. In all the granite hills throughout the State we find the same is true, and hence have sought to learn the cause, and the following are our conclusions: In the remote periods of the past, when this portion of the continent was submerged, in obedience to the same law that now causes the iceberg to move from the poles towards the equator, there existed powerful currents from the north bearing along icebergs which, striking against the northern side of these piles of granite, gradually wore off the summits, giving to them the smooth and gradual slope which we now behold upon their northern sides.

We do not propose to make long discussions here upon scientific points. But thinking the tourist would derive more pleasure, in contemplating the sublime mountain scenery of our State, by having thought awakened and carrying back his mind to the time when our mountains were submerged and subjected to the same abrading agencies that now are wearing down the inequalities of the ocean's bed, we thought the digression would be

pardonable if we called attention to the fact, and sought briefly to give the *modus operandi* by which nature had put on the finish to this portion of her mighty work.

The principal mountains of this division are Granite Hill, in Norton; Mount John, in Holland; Bear Hill, in Morgan; Bluff Mountain, in Brighton; Mount Pisgah and Mount Hor, in Westmore; Mount Seneca and East Haven Mountain, in East Haven; Umpire and Burke Mountains, in Victory; Joe's Hill, in Cabot; Mack's Mountain, in Peacham; Pigeon Hill and Pine Mountain, in Groton; Knox Mountain, in Orange; Cobble and Mill-Stone Hills, in Barre; Ascutney Mountain, in Windsor; and Black Mountain, in Dummerston.

RED SANDROCK MOUNTAINS.

The fourth division of mountains is found in North Western Vermont, and consists of a series of uplifts in Addison, Chittenden and Franklin counties. They have a character decidedly unique, the peculiarities of which are the gradual slope upon the eastern side, and the bold and rugged escarpment upon the western. The rock of this series of mountains is usually a limestone or calcareous slate, dipping to the east, capped with a silicious rock known as the "red sandrock." Snake Mountain in Addison, and Buck Mountain in Waltham, are the most elevated peaks of this division. A person standing upon Snake Mountain and looking to the north can count ten uplifts, each of which present essentially the same outline as the one on which he stands. While viewing this scene, the contemplative mind at once is led to reflect upon the agencies that have been at work to produce this series of hills so uniform in their structure and so similar in their outline. In all of them is found the same uniform slope of the strata to the east, with their abrupt termination upon the west. These, being sedimentary, must have been originally nearly horizontal, and extended much further west than their present terminus. Did they ever extend as far west as the Adirondacks, and did their proximity to those igneous rocks render them changed in their nature, and friable and more easily disintegrated than at points more remote? If so, is the wide valley, extending west from these uplifts to the Adirondacks, including the deep bed of the lake, one of erosion? Inquiries like these will naturally arise in the mind of the thoughtful spectator as he examines these interesting mountains; and, were we called upon to give our opinion, should decide these questions in the affirmative.

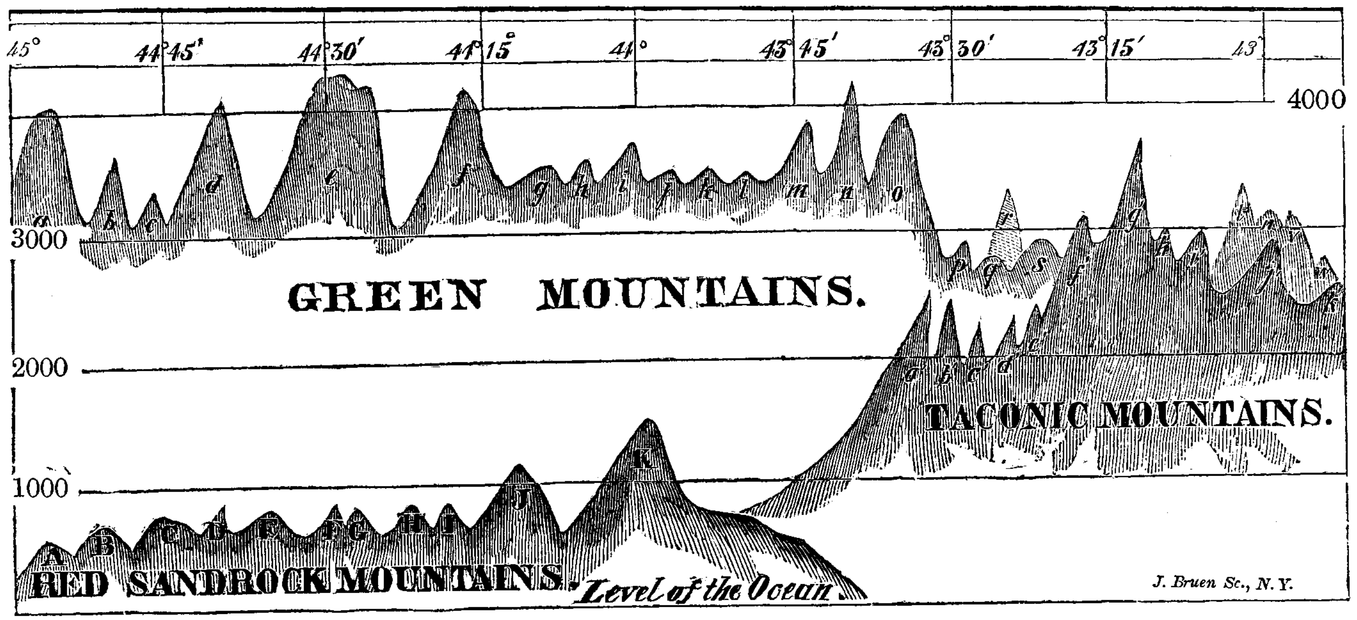
The phenomenon of a deep valley where limestone approaches near to, or comes in contact with, granitic rocks, is not restricted to this locality, but we know of no instance where such is not the case. Whether the intense heat of the granite was communicated to the limestone in sufficient quantity to change its character by expelling a portion of its carbonic acid, or whether the intense lateral pressure, everywhere exerted upon the earth's crust, served to shatter the edges of the strata of limestone where they abutted against or overlaid the crystalline rocks, are questions that we do not propose to discuss in this place, but will suggest that inquiries like these may be profitable to those visiting the red sandrock range of mountains.

The principal peaks of this range are Bridgeman's Hill, Franklin; Rice Hill, in Highgate; Prospect Hill, in St. Albans; Snake and Cobble Hills, in Milton; Mutton and Pease Hills and Sugar Loaf, or Mount Philo, in Charlotte; Florona, in Monkton; Shell-

House Mountain and Mars Hill, in Ferrisburgh; Buck Mountain, in Waltham; and Snake Mountain, in Addison.

The following cut is intended to exhibit to the eye the altitude of the principal mountains in Vermont whose heights have been determined, and also as far as possible to show the relative position of each as if viewed from the west. The figures at the top denote the latitude, and those at the sides the altitude above tide water in feet. The letters refer to the names, &c. below.

Fig. 335.



Green Mountain Peaks.

		Feet above the Ocean.
a	Jay Peak,	4018
b	Montgomery Mountain,	
c	Round Mountain,	
d	Sterling Mountain,	3700
e	Mansfield Mountain,	4348
f	Camel's Hump,	4083
g	Potato Hill,	3986
h	Bread-Loaf Mountain,	
i	Moosalamoo Mountain,	
j	Nickwacket Mountain,	
k	East Peak,	
l	Spruce Peak,	
m	Pico Peak,	3917
n	Killington Peak,	4180
o	Shrewsbury Peak,	3845
p	Saltash Mountain,	2850
q	White Rocks,	2532
s	Mount Tabor,	
t	Stratton Mountain,	
u	Somerset Mountain,	
v	Bald Mountain,	3124
w	Prospect Mountain,	2690

Taconic Mountains.

		Feet above the Ocean.
a'	Bird Mountain,	
b'	Herrick Mountain,	2661
c'	Spruce Knob,	
d'	Moose Horn Mountain,	
e'	Haystack Mountain,	
f'	Eolus Mountain,	3148
g'	Equinox Mountain,	3706
h'	Red Mountain,	
i'	West Mountain,	
j'	Mount Anthony,	2505
k'	Petersburg Mountain,	
r	Ascutney (belonging to the granitic division in Eastern Vermont),	3320

Red Sandrock Mountains.

		Feet above the Ocean.
A	Bridgeman's Hill,	
B	Rice Hill,	
C	Prospect Hill,	
D	Snake Hill,	912
E	Cobble Hill,	827
F	Mutton Hill,	
G	Pease Hill,	
H	Sugar Loaf,	
I	Florona,	1035
J	Buck Mountain,	
K	Snake Mountain,	1310

Since arranging the above, we have read a paper on the "Apalachian Mountain System," by Prof. A. Guyot, of Princeton, N. J., from which we obtain the following list,

embracing various points, and the height of each above tide water, as reported by him through the Am. Jour. Sci., Second Series, Vol. XXX, p. 157:

	Feet.		Feet.
Manchester Railroad Station,	713	Waterbury Station,	525
Manchester Village Court-house,	864	Hogback Mountain,	3648
Equinox, highest peak,	3872	Stowe Village, east of Mansfield Mt.,	700
Rutland Depot,	530	Mansfield Mountain, the Nose,	4094
Herrick Mountain, Ira,	2692	Mansfield Mt., the Chin, highest point,	4430
Shrewsbury Peak,	3845	Sterling Mountain,	3700
Pico Peak,	3954	Camel's Hump,	4088
Killington Peak,	4221	Lincoln Mountain,	4078

MANSFIELD MOUNTAIN.

Mansfield Mountain derives its name from a township in which it was situated, but which has ceased to exist as a township — it having been divided and set off to the towns of Underhill and Stowe. The mountain consists of three peaks lying in a line north and south,— which present when viewed at a distance from points east or west of it a striking resemblance to the profile of a man's face looking upward. In consequence of this fact the three summits have received the appropriate names of Chin, Nose and Forehead, or Southern Peak. When the fact is stated that the Chin is the highest point of land in Vermont, it might be conjectured by those who never saw the mountain that the profile is ill-shaped and disproportionate; for if it were not the profile of an idiot it might be inferred that the forehead or nose would be higher than the chin. But to such it may be said that the outline has the appearance produced by the face of a person when the body is in a supine position, with the head tipped back, and the chin elevated more than the other parts of the face.

This mountain is conceded by all to be the highest in the State, but there exist slight discrepancies in the measurement made by different individuals. Capt. Alden Partridge made the height of the Chin to be 4279,—E. F. Johnson, Esq., by a trigonometrical measurement made it 4359,— Prof. Zadock Thompson 4348; and by a barometrical measurement made by us on the 28th of July, 1857, the height indicated was 4329 feet above the ocean. The height of the Chin is about 340 feet above the Nose or middle summit, which has an altitude of about 160 feet greater than the Forehead or South Peak.

The Chin furnishes one of the grandest and most extensive views in New England. Standing on its summit in a clear day, the observer looks down upon the country extending from the base of the mountain to Lake Champlain as he would upon a map, and beholds in the outspread panorama an agreeable diversity of hills and valleys, forests and cultivated fields, villages and streams of water. Further along in the picture may be seen Lake Champlain, which at intervals is observed, far to the north and south, peering out in the blue distance like inlaid masses of highly polished silver, to give light and beauty to the scene. The valley of the lake may be traced its entire length, beyond which arise the majestic and picturesque Adirondacks, which give a romantic beauty to the background of the picture, and terminate the vision in that direction by their numerous pointed summits.

Turning to the east, the wavy line of the horizon is broken by the sharp outlines of the White Mountains, which rise up in the dim distance sixty miles off, and form a marked feature in the landscape, while the intervening space is filled with innumerable summits of hills and mountains, with deep extended valleys, showing the location and courses of the Connecticut, Winooski and La Moille, and their numerous tributaries.

To the north can be seen the wide-spread valley of the St. Lawrence, and by the aid of a glass in a clear day steamers may be seen gliding upon its waters. The well-known figure of Montreal Mountain rises in the hazy distance at the north, and Owl's Head is seen peering up amid other gray summits, far to the north-east.

To the contemplative mind this is a spot of unusual interest, and well calculated to inspire one with reverence for Him who hath made all so majestic and beautiful. To the student who reads the book of nature, there is revealed a page of instruction on this mountain. The vegetation of the summit is materially unlike that at the base—the trees are those only of the most hardy kinds, and of a stinted growth—and the shrubs are essentially different from those of the valley below. Here he finds what is common in New England, in swamps and upon the seacoast, beds of peat and the *sphagnous moss* that produces them. It is well known that this moss will grow only upon moist lands; then why should it be found upon the summit of this mountain? Had the weather been of the most agreeable kind at the time of our visit, perhaps the solution would not have been so readily and forcibly presented.

A pleasant morning dawned, and when we arrived at the summit the sun shone clearly, but beneath us were clouds in isolated patches, which at intervals served as curtains to hide the beautiful prospect below and west of us. Like contending armies

"——— moving nigh in slow
But firm battalion,"

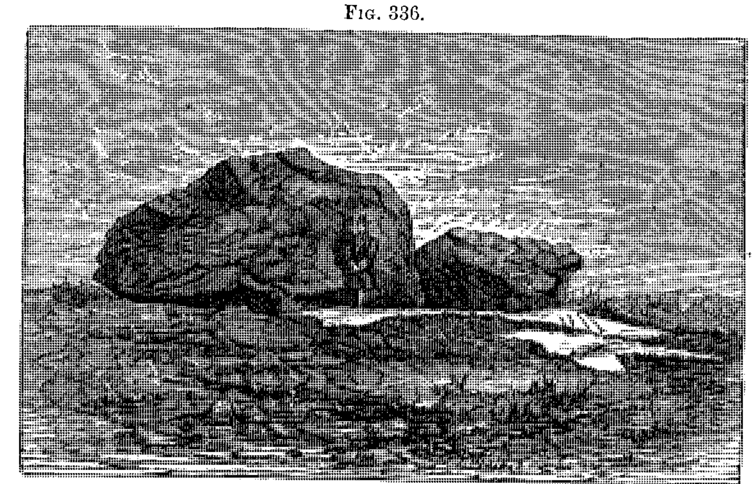
the clouds approached each other, and soon completely hid from view all to the west. But the change of the programme did not diminish the interest of the scene. Below and slowly approaching us, were the dense clouds whose upper surface in spots waved in romantic beauty, and in others lashed furiously to and fro like surges on the angry sea, and gave evidence of the commotion within; and the deep thunder—unattended by lightning—gave additional solemnity to the interesting scene. Soon in fitful coruscations the clouds reached us, and wasted their spray upon the summit of the mountain. We became gradually enveloped in them, and, ere we had taken time to bring back our minds from the wild beauty of the scene before and around us, were as thoroughly drenched with wet from the spray as though we had been plunged beneath the waves of Lake Champlain.

The continued moisture, communicated to the summit of the mountain by the clouds, is sufficient to sustain the growth of the moss, and the basin-shaped cavities upon the mountain afford reservoirs for the reception of the water necessary to preserve the roots and vegetable matter that make up the peat beds.

At a point about one-third the distance between the Nose and Chin may be seen "*drift scratches*" upon the rock; and the identical rock that formed them. Two bowlders of about thirty and forty feet in circuit lie near by, reposing against a firm barrier that doubtless wrenched them from their icy matrix as they were recording the history of the iceberg epoch upon these tablets of stone, which record was to reveal to man the fact that

even Mansfield's lofty summit was once beneath the ocean, and icebergs sailed majestically over it. That others may readily recognize the spot, should they ever be so fortunate as to visit the top of this interesting mountain, a sketch is here introduced, by the aid of which they will be enabled to find the "scratches" and bowlders above alluded to. The striæ are imperfectly shown in the cut in front of the smaller bowlder, but are very clearly shown upon the smoothed talcose slate of the mountain, and also in the stereoscopic view by Miller, from which the sketch was taken.

Fig. 336.



Drift Striæ on Mansfield.

The ascent of the mountain may be made upon either side, in good roads, and, when desirable, persons may ride to the top with ease and safety.

William H. H. Bingham, Esq., through whose persevering efforts the road was constructed from Stowe to the top of the mountain, erected a hotel in 1858, called the "Summit House," near the *Nose*, which was twenty-four by forty feet square; but, proving too small, an addition thirty by fifty feet square was made to it in 1859, and finished in good style at an expense of over two thousand dollars. A view of this hotel and the "Chin," as seen from beneath the Nose, is given in Plate XXI, which was engraved from a photograph taken by Charles Miller, Esq., of Burlington, in 1860.

Thousands of persons visited this mountain in 1859–60, and this spot is destined to become one of the favorite resorts of those who fully appreciate and admire the beautiful in mountain scenery.

STERLING MOUNTAIN.

Sterling Mountain is about four miles north-east of the "Chin," in the township of Morristown, and like Mansfield derives its name from the town that once existed in which it was situated. The altitude of this mountain is a little less than four thousand feet, and were it not for the proximity of Mansfield would doubtless be regarded as one of the favorite resorts for "sight seeing;" for the same enchanting glories are visible, from this peak, that meet the eye on Mansfield.

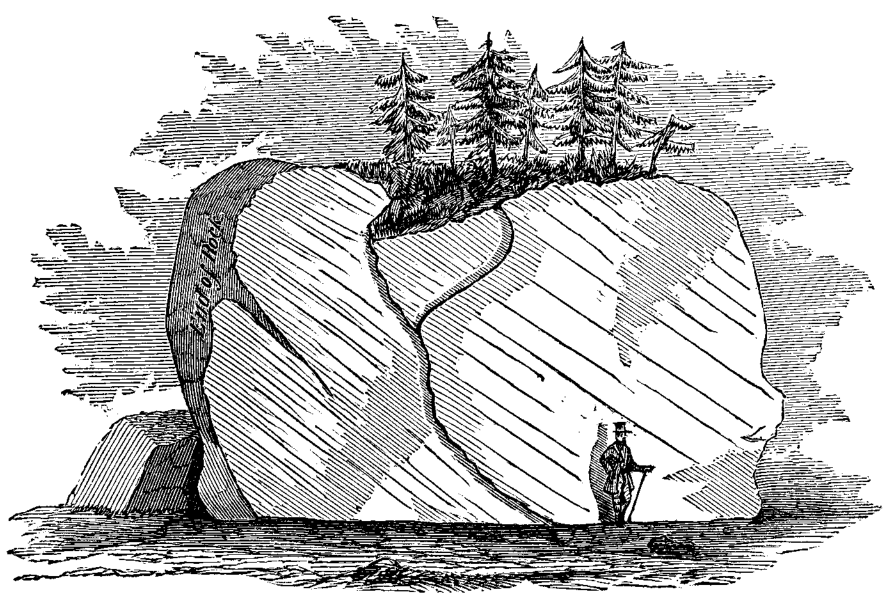
SMUGGLER'S NOTCH.

Between Mansfield and Sterling Mountains a deep gorge intervenes, known as "Smuggler's Notch," through which in the early settlement of that part of the State a "bridle road" was kept open, and tradition says contraband goods were secreted in and found their way through it; but latterly no one disturbs its solitude, except it be a hunter or one seeking an exhibition of nature in her wildest and most romantic haunts. To the latter there is here opened a rich field — for even the far-famed "Franconia Notch" presents no wilder views or towering precipices, than are found in this sequestered glen.

Entering this deep gorge from the south, about six miles north of Stowe, the traveler encounters a dense dark forest, through which a comfortable wood-road passes by the side a brook for the distance of a mile or more. A bridle path is then followed about two miles, and the "Mammoth Spring" is reached. This spring—which is about five hundred and sixty-two feet above Stowe village, and one thousand two hundred and sixty-two feet above the ocean — shoots out from beneath Sterling mountain, and forms a brook of considerable size that courses its way south and widens into West Branch, the principal tributary of Waterbury River. Occasional glimpses of the sterile peaks of Mansfield are caught from the road leading up to the spring, and, as the latter spot is approached, the precipitous-walled sides of Mansfield and Sterling mountains crowd more closely upon each other, and are not more than twenty rods apart. Bowlders of gigantic size lie scattered in the gorge near the spring and are quite numerous north of it; but in the southern portion they are only rarely seen.

It is a noticeable fact that upon all these bowlders there is more or less of soil or vegetable mould, and upon many of them are trees growing a foot or more in diameter. One of the bowlders, about eight rods north from the spring, has four spruce trees growing upon it, either of which is at least fifty feet high, besides numerous smaller trees and shrubs. This rock has been christened Bingham's Rock, and is thirty-five feet long, twenty-five feet high, and about twenty-one feet wide, a representation of which is given in the following cut.

Fig. 337.



Bingham's Rock.

Further north are seen many larger bowlders, but none more symmetrical than this. Among the larger ones measured is one which we call C. Allen Browne's Rock, in allusion to the jovial and gentlemanly companion who accompanied us to the spot at the time of our first visit thither. This bowlder is five rods long, about twenty-five feet high, and thirty feet wide, and has upon it trees one foot or more in diameter.

Why the rocks should be covered with soil, and what is the reason of the remarkably rich soil in the bottom of that gorge, were questions of interest to us; and unless the richness is attributed to the fact that the winds are cut off by the high mountains around it, so that not only the leaves from the vegetation in the gorge are suffered to remain in the place where they fall, but others are brought from a distance and lodged there, we are unable to give a satisfactory solution for its unusual fertility. The soil upon the bowlders appears to be a black vegetable mould, just such as would naturally be produced if leaves were suffered to fall and remain for centuries, undisturbed by winds or other agencies.

West of the Smuggler's Notch, upon a northern spur from Mansfield, lies the Lake of the Clouds, a crescent-shaped pond, in full view from the "Chin," one of the most elevated bodies of water in New England, being five thousand feet above the ocean. A stream issuing from this lake, after running about one-fourth of a mile, tumbles down the precipitous walls of the notch, and breaks the stillness of the spot by the music of its waters. From the Mammoth Spring to the northern opening of the gorge the perpendicular and overhanging walls of rock are numerous, and rise up on either side in majestic grandeur, threatening to fall and crush whatever may be below them. It is quite evident that those huge bowlders fell from the adjacent ledges, and, in some cases, their downward course is traced upon the slope of land beneath the cliffs, and their length of leap is given by the distance between the deep indented holes along the path.

Near the northern opening of the notch, and about four miles from Carlton's hotel, in Cambridge, and about eight miles north of the village of Stowe, is a large rock, about sixty feet in circuit, which became detached from its parent bed far up the mountain side, about fifty years ago, and came thundering down into the valley, laying waste the giant trees and whatever chanced to be in its downward path, and producing a rumbling sound not unlike an earthquake, which was heard afar off, and shook the hills for miles around. From the fact that the great "slide," of which the above named rock formed a part, occurred on the day of the birth of Barton Ingraham, whose parents resided in the neighborhood, the rock has received the name and is known as "Barton's Rock."

As this romantic spot was not visited by the Principal, and our notes upon it are, perhaps, vague and imperfect, it was lost sight of in the chapter treating of eroded valleys; but, from all the attending circumstances, it is evident that strong currents from the north plowed through this gorge, and gradually wore down the barrier that once existed here, and thus the valleys of the La Moille and Winooski were united.

MOSS GLEN FALLS.

At the time of our visit to Mansfield we became acquainted with C. Allen Browne, Esq., of Boston, Mass., who accompanied us to the places of interest in the vicinity of Stowe. He first called our attention to the beautiful cascade represented on Plate XXIX, and we can describe it in no language more appropriate than to use his description as communicated in the following letter:

A. D. HAGER, ESQ.: STOWE, SEPTEMBER 25, 1860.

My dear Sir,—"The present time is the only time," is a good old proverb; and I seize upon it to describe a lovely little gem found in this neighborhood. It is about three miles from the village—a pleasant drive—and in a gorge of one of the Worcester Mountains. It is called "Moss Glen Falls." The approach to it is very beautiful. The ascent over and around it, and the look-out into the deep caverns below, are easy of access and secure from danger,—so that the most timid can enjoy their fullest beauties.

The source is from a lake in the mountains, and the water flows through a deep dark gorge in the rocks about one hundred and fifty feet, and falls abruptly forty feet into a deep basin, called "Richardson's Bowl." From thence it rushes over a broad, dark-colored, solid body of rock, spreading itself into a rich, silvery cascade, and falling sixty feet into another basin, called "Whitney's Cup." This basin—Whitney's Cup—is surrounded on one side by dark overhanging cavernous rock. On the opposite side is a perpendicular cliff of solid rock one hundred and thirty feet in height.

The upper basin—Richardson's Bowl—is in a complete rotunda; and as you stand in the entrance witnessing the rush of water and the falls, it impresses the beholder with solemn grandeur. It is about seventy-five feet in diameter, ninety feet high, with an opening at the top of about twenty-five feet. The dark cavernous opening or river through which the water rushes, is about thirty feet wide at the base—narrowing as it approaches the fall—and only about ten feet wide at the top.

A few days since I got our friend Bingham—"king" of the famous Mansfield Mountain—to accompany me, together with a strong-armed and muscular woodsman, by the name of Spaulding—joint owner with his brother of the lands surrounding the fall—for the purpose of felling some trees which obstructed the view at certain points. At one of these points—upon an overhanging rock which projects over the dark gorge leading to the falls—the trees were removed, and I sat down to enjoy the sight. While viewing the scene, out pops the head of an old and venerable-looking man wearing a full dress wig. His countenance betokens firmness and decision, and it is apparent that he is intently watching some object. Soon I observed a colossal female head with Grecian features, looking out from the opposite side and down into the dark river below: this face betokened quiet and repose. In my surprise at the discovery I cried out, Bingham! Spaulding! Who are these people? They both rush to the spot and gaze in astonishment. I never saw them before! I never heard of them before! were their replies. Is there no record of any of your ancestors having been turned into stone, I inquired. Spaulding could not remember of ever having heard anything of the kind. Bingham, with a quizical look, said he did not know that any of his had been turned into stone, but had a faint recollection that one on the female side was changed to a pillar of salt!

This is a very curious and interesting scene, and the sight seeker should not miss of it. It needs a strong light—a mid-day sun—to get the true beauties from this point in the dark ravine. The various positions from which the fall, cascade and basins are seen as you walk along the border, looking out and down into them, give pictures beautiful, startling and sublime. There is one view of the fall and cascade which is as wild and beautiful as anything I ever saw. It is equal to any of the pictures among the Tyrol Mountains.

The longer I remain in this lovely valley of Stowe, the more am I impressed with its surrounding beauties. It is strange that our artists have not been here to freshen and nourish their love of the beautiful, and given to the world some of its unsurpassable landscape scenery.

Yours truly,

C. ALLEN BROWNE.

CAMEL'S HUMP.

This well known summit of the Green Mountains is situated in the towns of Duxbury and Huntington, and forms a dividing line between the two. It has an elevation of 4083 feet above tide water, and the prospect from it is excelled in beauty and extent by no mountain in the State. Its isolated position, and the strongly marked and peculiar outline of its summit, which suggested its name, makes a conspicuous and easily recognized object from a large portion of the Champlain valley.

Through the kindness of Mr. Frank R. Rathbun, a young artist from Winooski Falls, we are enabled to give a good "back-ground" view of Camel's Hump, as seen from the lake at Clay Point, in Colchester. (See Plate XXVII.) By referring to the plate, it will be seen that the mountain is situated like a huge observatory, towering far above the surrounding country, and affording from a single point one of the most extended and varied views any where to be found. The same enchanting prospect of Champlain Lake and valley is here afforded that is seen from Mansfield Mountain, and to the east is outspread a rich and varied landscape that extends to the hazy summits of the White Mountains. No mountain peaks encroach upon the north or south to hide the prospect, but from the base towards either point along the Green Mountain range may be seen a beautiful succession of peaks, that gradually fade out as they rise beyond each other in the blue distance.

The summit of the mountain may be reached from Ridley's Station,* which is six miles from it, on the Vermont Central Railroad, by a good road, up which persons may ride in carriages three miles, and from thence on horse-back to the top.

Not far from the summit, near an excellent spring of pure cold water, are erected a hotel and barn for the accommodation of visitors. At this *Green Mountain House* persons may tarry for the night, or, from the well-spread tables, get such refreshments as are suited to the tastes of the most fastidious. Another route to the summit is from Huntington, from whence there is a road, up which persons may ride nearly the entire distance.

The pleasant village of Waterbury is only about ten miles distant from the summit, and Montpelier about twenty miles to the east, and Burlington lies within thirty miles upon the west. Surrounded by these places, and the numerous other thriving villages that are planted in full view from its summit, Camel's Hump cannot fail to become a favorite resort for those who would wisely combine healthful exercise of the body with well-directed recreation of the mind.

JAY PEAK.

Jay Peak, situated in the towns of Jay and Westfield, belongs to the same range as those before described, and does not vary much in height from them, having an altitude of 4018 feet. Although the same extended view of Champlain valley is not obtained from the summit of this peak as from those heretofore described, yet the observer is compensated for this deprivation in the more extended views afforded in the valleys of the St. Lawrence, Ottawa, and Lake Memphremagog. To the north-west the spectator beholds the level and fertile country surrounding Montreal, contrasting beautifully with the wild and rugged scenery at the north and north-east of him, where are seen thickly-studded mountain peaks, prominent among which are Sutton and Orford mountains, Sugar Loaf, and Owl's Head. Between Sutton Mountain, in Canada, and Jay Peak, is the deep valley of the Missisquoi, which, like the Winooski and La Moille, winds its way through a valley about 3500 feet below the summits of the mountains on either side. It is a singular fact that the three streams before named pass between, and not far from, the highest peaks of the Green Mountains; and at the points between the peaks the streams are not in any case more than five hundred feet above tide water.

*North Duxbury P. O.

From the top of this peak may be seen a number of villages near its base. The beautiful villages of Montgomery, Richford, Berkshire, Westfield, Lowell, and Troy, are partially visible from the summit. Hazen's Notch, which lies within a short distance, is an object of interest to the tourist, and is gradually becoming more and more resorted to by lovers of grand and picturesque scenery. The fertile valley of the Missisquoi—which is confessedly one of the most productive, as well as beautiful, in the State—is plainly visible from the summit of Jay Peak; and the eye delights to linger on the attractive scenery with which the counties of Franklin, La Moille and Orleans abound.

No road is yet completed to the top of this peak, but one is contemplated from Westfield—to extend from a road now existing about three miles from the summit. This mountain is composed mainly of talcose slate, with occasional intercalations of serpentine and soapstone.

MOUNT KILLINGTON.

Killington Peak, so named from the town of Killington, now Sherburne, is situated in the towns of Mendon and Sherburne, and about ten miles east of Rutland village. Its height, as determined by Capt. A. Partridge, is three thousand nine hundred and twenty-four feet.

By a measurement recently made by Prof. Guyot, Killington is found to be four thousand two hundred and twenty-one feet in height. There was evidently an error in the elevation as given by Capt. Partridge—not in the computation, but in the mountain. Three prominent conical peaks are seen to the north-east of Rutland, as shown in Plate XXIV, and discussions have arisen as to which of the three was Killington. Prof. Zadock Thompson—ever considered good authority in Vermont—in his Gazetteer, says "the south peak is the highest." Now the south peak (Shrewsbury) is found by Prof. Guyot to be three thousand eight hundred and forty-five feet high, and we are forced to the conclusion that it was Shrewsbury, not Killington, that was measured by Capt. Alden Partridge.

Upon ascending Killington, any one will be satisfied that its elevation is much greater than any of the surrounding peaks which he can look down upon. Hence it is evident that Killington is the middle (the one with a bald summit), while the one at the north is Pico, and the southern or right hand one is Shrewsbury Peak, as shown in Plate XXIV. From the proximity of this mountain to the thriving village of Rutland, with a good wagon road leading to within three miles of the summit, it will not long remain unvisited by the "pleasure seekers," whose increasing numbers during the summer months throng our good hotels and boarding-houses. During the fall of 1859, Leverett Wilkins, Esq., an enterprising citizen of Mendon, constructed a road up the west side of the mountain, thus furnishing an opportunity for persons to ride on horseback nearly to its summit.

A "Tip Top House" for the accommodation of the weary traveler has been constructed of boughs with sides of rock, and will be open at all times for the reception of guests. Within eighty rods of the summit are three springs of water, such as are found upon nearly all the peaks of the Green Mountains—cool, pure and limpid—and well calculated to refresh and invigorate one in a hot summer's day, after a two hours walk. The view from this summit is as extensive as that from Mansfield, but there is not that diversity of landscape.

Instead of Lake Champlain, with its numerous bays and verdant islands, and the intervening cultivated farms, there is spread out before the spectator a scene more wild, solitary, and rural.

Having had an invitation from friends residing in Pomfret, Vt. to visit Killington, and remain upon its summit during the night, the writer, in company with Melvin Wright, left Proctorsville, with the intention of reaching the summit early in the morning, in season to take the morning meal with friends who were intending to encamp upon the mountain during the previous night. Arriving near the summit from the Sherburne side, just as the gray of morning was waking, we reached a point exhibiting the dwarfed shrubbery ever found at an elevation of four thousand feet in Vermont. Through it we hastened to reach, if possible, the summit in season to behold the beauties incident to a mountain sunrise. Chilly blasts of air, refreshing to our heated bodies, swept swiftly by us, ever and anon bringing with them fragments of spray from the swift flying clouds just above our heads. As one of these vapory streams was rushing towards us from the south-west, it seemed arrested in its course as though to give an opportunity for us to scan its character, and admire its beauty. Looking above this wreath of fog we distinctly saw, at intervals, our friends above the clouds several rods distant, and more than fifty feet above us. The rocky base on which they stood was hidden by the cloud that lay close bound around it; and at times our friends were wrapped around with fog so dense as to exclude them from our view, and again as quick as thought the curtains would be drawn, and they again appear between us and the morning sky. Admiring this awhile, we hastened on and soon ascended the pinnacle of gneiss upon which our friends were standing, whom we found impatient to have the clouds disperse that hugged the rocks around that mountain peak, that they might see beyond the misty veil that hid the distant prospect. The sun arose, and soon the clouds dispersed, and we beheld immediately around us an unbroken wilderness, except an occasional spot where some hardy woodman had made him a home. As our eyes receded from the mountain to the west, we beheld in full view the thriving villages in and around Rutland, north of which we traced the numerous windings of Otter Creek, and discerned many substantial farm-houses upon its fertile banks.

Further on in the picture, the Taconic Mountain range became a prominent object for our admiration; and among its numerous peaks Equinox, Eolus and Bird Mountain were quite prominent.

To the south-west Shrewsbury Peak showed its wild woody sides, and to the north, crowding close upon the base of Killington, was seen the cone-shaped peak called Pico, the dense forests of which had never been broken by a blow from the woodman's axe.

Stretching the eye to the east far beyond the wild surroundings of the mountain, the prospect was quite extensive as will be seen by the reports made by Hosea Doton, A.M., of Pomfret, and Henry Wolcott, Esq., of Quechee, both of whom we found upon the mountain, each having a transit instrument, a thermometer and a telescope. In addition to the camp equipage necessary for the comfort of the party who were to bivouac upon the summit, these instruments and a barometer had been taken up the mountain by the company, consisting of five ladies and fourteen gentlemen including the guide.*

*We here give the names of the party that spent the night upon the mountain, which are as follows: Hon. Crosby Miller, M. H. Miller, Hosea Doton, Charles A. Adams, A. B. Chandler, Edward A. Chandler, George T. Vail, Justin Bugbee, Herman Bugbee, Julia R. Ware, Mariette S. Adams, Ellen S. Chandler, Mary E. Chandler and Ellen M. Miller, of Pomfret; Charles Tinkham, Henry Wolcott and William S. Dewey, of Quechee, and Miss Martha A. Grannis, of Claremont, N. H.

Soon after our return home, we received the following letter from H. Wolcott, Esq., which sufficiently explains itself:

QUECHEE, SEPTEMBER 14, 1860.

MR. HAGER:

Dear Sir,—I write to redeem the promise which I made at Sherburne, to send you the minutes, or results, of such observations as were made by me on Killington Peak. The variation of the magnetic needle proved to be 10° 36′ west, which is about the variation at this place, and of this section generally. The latitude deduced from an observation of the sun's meridian altitude I make 43° 35′45″, which agrees very well with its position on the new State Map. The angle of depression of Ascutney was 39′, which, allowing the distance to be twenty-two miles (the shortest I can make it on any map), gives, after allowing for curvature and refraction, 1050 feet as the height of Killington above Ascutney. In Thompson's Gazetteer of Vermont the height of Ascutney is given as 3320 feet, which makes the height of Killington 4370 feet; from which I infer that Ascutney must have had his high-heeled boots on when his measure was taken. The angle of depression of Monadnock was 35′, which, calling the distance sixty-six miles, gives 1053 feet as the height of Killington above Monadnock. In Morse's Gazetteer the height of Monadnock is given as 3254 feet, making the height of Killington 4307 feet. From all these observations, I am inclined to believe that Killington has been underrated, and the others probably somewhat overrated. I am inclined to think that the height of Killington, as given on the new State Map (upon what authority I do not know), 4180 feet, is not far from the truth. I took but very few bearings of distant objects and places, and those were given to Mr. Doton, who, I suppose, will send them to you with those he took, which were quite numerous.

If any of the foregoing will be of use to you, I shall be happy to have furnished them, and if not, you will have but to throw them aside and forget them. There is one fact, however, in connection with them which I think you will *not* forget,—I certainly shall not,—that is, our getting lost and off the track in coming down the mountain.

Truly yours, H. WOLCOTT.

We also requested Mr. Doton to furnish us with the result of his observations, to which he kindly responded by sending us the following tables:

In this table are shown the bearings of some of the different mountains, &c., from the summit of Killington Peak, from observations taken August 30, 1860, by H. Doton, A. M., the magnetic variation being 10° 36′ west, as deduced from observations on the Pole Star, made at the time by Henry Wolcott, Esq.

Camel's Hump,	North	6½°	East.
Mansfield Mountain,	"	10½°	"
Pittsfield Village,	"	10½°	"
Owl's Head Mountain, Canada East,	"	32°	"
Randolph Center Village,	"	35°	"
Westmore Mountain (Pisgah),	"	38½°	"
Mount Washington, N. H.,	"	67½°	"
Cardigan Mountain, N. H.,	South	84°	"
Ascutney Mountain,	"	60°	"
Gunstock Mountain, N. H.	"	44°	"
Monadnock Mountain, N. H.,	"	25°	"
Eolus Mountain (Green Peak),	"	34°	West.
Equinox Mountain,	"	36½°	"
Rutland Depot,	North	79°	"
Mount Marcy (Adirondack range, N. Y.),	"	46½°	"
Whiteface Mountain (Adirondack range, N. Y.),	"	35°	"
Pico Mountain,	"	7°	"

A table showing the state of the barometer and thermometer, from observations taken on the summit of Killington Peak, August 29 and 30, 1850, by H. Doton, A. M.:

		Barometer. Inches.	Thermometer. Degrees.
August 29, 1860, at	7 o'clock, P. M.,	25.84	45
	8 " "	25.84	45
	9 " "	25.83	44
	10 " "	25.84	43
	11 " "	25.84	43
	12 " midnight,	25.86	44
August 30, 1860, at	1 " A. M.,	25.90	44
	2 " "	25.91	44
	3 " "	25.89	44
	4 " "	25.86	45
	5 " "	25.835	45
	6 " "	25.84	45
	7 " "	25.86	45
	8 " "	25.86	45
	9 " "	25.87	46
	10 " "	25.905	49
	11 " "	25.90	53

At the time of leaving the party for our home we were flattered with the hope that Mr. Doton would ascertain the height of the mountain, by carrying up a series of levels from some known base line, but received from him a letter from which the following is an extract: "I have not been able to measure the height of Killington, and have felt less anxiety about it for the reason that I supposed Prof. Guyot's admeasurement would be considered as reliable. * * * * I will, however, give a few of the heights that I have obtained, based on the point at White River Junction:"

	Feet
Top of Railroad track in front of depot at White River Junction,	351
North Hartland Railroad Crossing,	353
Surface of Pond, Quechee village, Hartford,	552
Base of Town Hall, Woodstock,	697.55
Green Mountain Institute, South Woodstock,	1072
Mount Tom, North Peak, Woodstock,	1351
Mount Tom, South Peak, Woodstock,	1244

Numerous other peaks and objects of interest in the Green Mountain range might be given. Haystack Mountain in Wilmington, one of the wildest, most rugged and imposing peaks in Southern Vermont is well worthy a description; so, too, are the "Calico Rocks" north of the gorge in Wallingford, where the water-worn quartz pebbles are piled and cemented together between beds of chloritic slate (see cut on p. 32, Fig. 8), forming a silicious conglomerate and portraying upon its smoothed surface not only the record of ancient "drift," but the more remote record of the time when those pebbles—now firmly cemented together—rolled upon the beach of the primitive ocean, as it washed the shores of a pre-Adamic continent.

And still others might be named,—but those examples already given will suffice to convey to the citizens of the State, and others, the fact that if they would temporarily occupy an elevated position in order to see a beautiful landscape, or contemplate upon the diversified exhibitions of nature in her pristine beauty and loveliness, they need not weary themselves with a journey to the summit of Mount Washington, but ascend, by a comfortable road to the favored points of observation, some of our interesting mountain peaks.

BIRD MOUNTAIN.

Bird Mountain, one of the most northern peaks in the Taconic Range — so named from the first white man who lived upon its sides — is in the town of Ira, about four miles east of the village of Castleton and eight miles from the village of Rutland. Its elevation above tide water is about 2500 feet. At all points on the mountain — except the north-east — the sides are so precipitous as to render the ascent nearly or quite impossible.— Even at this place the ascent is so steep as to preclude the possibility of going up on horse-back the entire distance, but by means of a comfortable foot-path and the bushes by its side one can quite easily reach the top, which is not more than one mile distant from a good wagon road. The summit consists of rock, and is nearly destitute of soil or vegetation. In this respect Bird Mountain is unlike other mountains of the Taconic Range. This arises from the fact that the rock of which the mountain is composed is a quartz conglomerate, not easily disintegrated, and its decomposition does not bring out those fertilizers so abundant in other parts of the range.

This mountain forms a prominent feature in the landscape, to those viewing it from the western part of Rutland County, and when seen from points directly west in connection with Herrick Mountain — which is also situated in Ira, but about two miles to the east of Bird Mountain — presents an outline the peculiarity of which is well calculated to arrest the attention and admiration of any one. It has the appearance of two mountains, equally distant, with a deep giddy chasm between.

The prospect from this mountain is not as extensive as from many other summits, still it is not devoid of interest. To the north-east through a narrow pass, are seen patches of white in the landscape, resembling banks of snow, but which upon close inspection prove to be the blocks and *debris* from the West Rutland marble quarries, the most northern of which are in full view from this mountain. In the opposite direction may be seen illuminated spots in the landscape, which mark the location of Lake Austin and Lake Bombazine. The church spires of numerous villages glitter in the west, and there is on every side an agreeable diversity of hills and valleys, woods and cultivated fields, to meet the eye of the spectator.

EQUINOX MOUNTAIN.

This, the most elevated peak of the Taconic Mountains, is situated in Manchester, and, according to the admeasurement of Prof. Arnold Guyot, is three thousand eight hundred and seventy-two feet above tide water.

By a measurement made by Joel W. Andrews, Esq., of Albany, N. Y., in 1859, he found the highest point of the mountain to be two thousand nine hundred and seventeen feet above Manchester village, and three thousand seven hundred and eighty-seven feet above the ocean.

Observations made by the same gentleman place it in latitude 43° 9′ 27″ N., and 15′ 32″ in time east longitude from Washington. The variation of the magnetic needle on its summit was found to be 9° 37′ 39″ W.

A good carriage road is built to the summit of this mountain, near which is erected a summer-house, where many a nice dinner has been served up for those who have ascended the mountain. The unsurpassed facilities for reaching the top of this mountain—by a carriage the entire distance—renders it a place of great resort.

The view from the summit is unsurpassed by any mountain of its height in New England. There is presented on every side a diversity of scenery. To the east is seen the smooth, unbroken and sharp-sided range of the Green Mountains, with scarcely soil enough to sustain vegetation of the most stinted growth. Swell above swell is seen as the eye extends still further to the east, and occasionally a more prominent peak arises, among which are recognized Monadnock and Ascutney mountains.

Turning further north, the unbroken range of the Green Mountains may be traced into the blue distance, with an occasional peak, as Killington and Pico; but the general appearance presented when viewing the top of the range is that of an undulating table land.

Around the north-eastern base of Equinox there is spread out a fertile and comparatively level country, extending to Eolus Mountain on the north, and to the base of the Green Mountains on the east. A view of this delightful country is given in Plate XXXIII, as seen from the northern observatory of the Equinox House. Eolus Mountain forms a prominent feature in the picture, and at a patch of white far up its south-eastern side, as shown in the sketch, may be seen the *debris* from the marble quarry of Messrs. Holley, Fields & Kent.

The heavy growth of timber, and the verdancy of the open fields on the sides of Mount Eolus, attest the fertility of its soil, while just across a narrow gorge that intervenes may be seen the stinted growth of scattering trees that strive for an existence upon the precipitous sides of the Green Mountain range. Looking westward, a scene agreeably diversified with hill and vale, fruitful fields and thriving villages extends from the base of the mountain into the dim distance. In favorable weather, with a glass, lakes Champlain and George can be seen at the bases of the mountains which terminate the view in that direction.

The southern view is over a succession of round-topped mountains, that lie closely piled together and extend far down into Massachusetts. The peculiar outline of Graylock is seen in the distance, and none acquainted with its contour would mistake it for another mountain.

This mountain, having been more extensively visited and more universally admired for its beauty and interesting surroundings, by sojourners from abroad, than any other one of its size in the State—the interesting points around it have been discovered and each has its name, and each is quite sure to receive a visit from those who sojourn in Manchester during the summer months: *Table Rock*, a projecting shelf of slaty rock, far up the south-eastern side; *Deer Knoll*, a hillock standing out from, but fastened to, the side of the mountain, from the rounded top of which a delightful prospect is visible; *Skinner Hollow*, an eroded valley south of the summit of Equinox, and in full view from it, in which a brook, the dwarfed representative of one that wore out this deep valley, is suddenly lost and disappears in the earth. These are all spots of interest, and should be visited by the tourist.

The *Orvis Rocking-Stone*, about two miles from the Equinox House, is an object of interest, and should be noticed. It is a calcareous slate rock, seventeen feet in length, eight feet wide, and five feet thick, and so nicely poised upon the ledge below it as to be easily tipped with one finger, and still so placed that ten men could not throw it from its bed. A view of this rocking-stone is given in Plate XXXI, from a photograph taken by Miller, of Burlington.

We regard this the best sample of rocking-stone* in the State, and probably the best in New England; for, were it not protected by forest trees, the winds alone would move it.

In no place in Vermont are so many sojourners from abroad during the summer months as are found at Manchester. And in no place in the State are hotels so superbly fitted up and so well calculated to give entire satisfaction to their guests as are the three public houses in Manchester. Of these the Equinox House stands pre-eminent. In addition to the products of a large farm which are appropriated to the use of the hotel, all choice luxuries from abroad are carefully selected, and add to the variety of the well-spread tables of this popular house.

An artificial trout pond—covering about ten acres of land, and fed by three mammoth springs that rush out near the base of Equinox Mountain and form a stream of sufficient size to drive the wheel of a saw-mill—is located on lands of the company about one mile from the hotel. Guests of the house are permitted to take out the speckled trout from this pond, and those weighing one and two pounds are not unfrequently caught. A view of this pond is shown on Plate XXXIV, with Red Mountain and the south end of Equinox in the back-ground of the picture.

Ornamental shade trees are set out, and a good carriage road is built around the pond; and, taken all in all, this is probably one of the most extensive, and thus far has proved one of the most successful experiments at trout-raising ever made in the State.

We are not disposed to leave this subject without referring to some of the advantages already realized by the citizens residing in the vicinity of Manchester, in consequence of properly appreciating and calling attention to the scenery that surrounds them.

The Messrs. Orvis, being admirers of the beautiful displays of nature, as seen in the superb handiwork around Manchester, decided upon fitting up a first-class hotel for the accommodation of summer boarders, believing the business men of the city would delight to spend a portion of the summer months in a spot so prolific in picturesque surroundings.

The result has far exceeded the sanguine expectation of these men, and the three hotels of the place proving insufficient to accommodate the summer boarders, a large addition to the spacious Equinox House was made the present season (1861.) A more ready market is made for products of the farm and garden than existed before this influx of the thousand or twelve hundred sojourners that annually congregate here.

*As this Report was passing through the press, we were informed by James Hutchinson, Jr., Esq., of Braintree, that a remarkable rocking-stone was in his town, about one mile north of the Center Meeting-house, upon land of Dea. Augustus Flint. In compliance with our request he has kindly furnished us with the dimensions and character of the rock, together with a sketch of the same. We regret that time will not permit us to obtain a wood cut from the sketch in season to appear in the Report. The rocking-stone is mica slate, highly metamorphosed, with sprinklings of garnet and numerous veins of quartz passing through it, having a circumference of forty-nine feet, being fourteen and one-half feet in length, ten feet wide, and seven feet high. It rests upon a fine-grained granite, closely resembling the conglomerate granite of Granby, Vt., and is so nicely poised as to enable a man to rock it with his hands. Numerous bowlders of granite and other rocks abound in the vicinity of the rocking-stone, and to the curious this is a spot well worth visiting.

The high price which the good accommodations of the place will secure from summer boarders, brings much money into circulation, and there is awakened a desire for improvement in the appearance of the village. Shade trees have been placed along the streets, the highways are made smooth to afford pleasant "drives," and the sidewalks of the streets flagged with slabs of sawed marble, affording the best opportunity for promenades anywhere found in the country. We claim that this great improvement of the village has resulted mainly from the magic dollar of the tourist who came here to live awhile amid the beautiful display of nature's handiwork.

EOLUS (DORSET) AND DANBY MOUNTAINS.

Eolus Mountain is situated in the town of Dorset, and is one of the Taconic Mountains. Its highest peak—usually called Green Peak—is about two miles west of East Dorset village, where by a measurement made on the 25th day of May, 1858, it was found to be three thousand one hundred and forty-eight feet above tide water. The northern part of the mountain—that portion lying in Danby—is called Danby Mountain, and it is upon this mountain that the numerous quarries abound, from which the Danby marble is obtained. These quarries are situated about twelve hundred feet above the village, to which the blocks are drawn to be sawed. On Eolus Mountain are several valuable marble quarries, the highest of which now worked—the Vermont Italian—is over one thousand two hundred and fifty feet above the railroad in the valley to the east of it. This mountain, like most of those of the Taconic range, is made up mainly of limestone, with a cap of talcose slate forming its summit. Unlike the rock of the Green Mountain range the strata forming this mountain are nearly horizontal, and the mountain being entirely disconnected from the others of the range, has the appearance that would be produced if some eroding agency had scooped out the valleys on all sides of it.

At an elevation of one thousand seven hundred and forty-two feet above the village of East Dorset is found a cave—which was evidently formed by water—sufficiently extensive to allow persons to penetrate it several rods. Further on than persons can travel—in consequence of the narrowness of the passage—there are doubtless extensive caverns, for a strong current of air rushes out from these narrow passages from the most remote parts of the cavern.

The ascent to the cave is not difficult, but from this point to the top of the mountain it is attended with all the inconveniences experienced in walking up a steep hill-side with no path, but with jutting points of rock, dead limbs, and a thick underbrush to impede the progress. The prospect from the mountain is magnificent, but much obstructed by the timber growing upon the summit. The thriving villages and fruitful fields in the broad valley of the Battenkill are spread out to the south, and the agreeable succession of hills and mountains rise up in the distance and give a sublime beauty to the background of the picture.

Upon this mountain may be seen a marked difference in the soil, in leaving the limestone and approaching the talcose slate that forms its summit. The vegetation upon reaching the slate is not only less luxuriant, but it is entirely changed in its character. The varieties of trees and shrubs that were abundant upon the limestone suddenly disappear upon touching the slate, and those of a more hardy kind succeed them.

Dikes — those veins of intrusive matter that fill the fissures of rocks — are quite common upon this mountain in all parts of it, some of which are very interesting.

The other peaks of the Taconic range, of which Eolus and Equinox Mountains are types, are less elevated, and probably the views — being less extended — are not so enrapturing as those before named; but in many places the steep escarpments and deep chasms, the sharp-pointed summits in contrast with the beautifully rounded hill-tops, lend a charm to the landscape that awakens admiration in the mind of the beholder.

A magnificent view of this description may be had about one-half mile south of the village of Pawlet, where a person standing upon a terrace in the valley of Pawlet River, and looking north, perceives near him terraces rising above each other in beautiful succession, then a portion of Pawlet village rises from the valley and shows itself — beyond which Haystack Mountain (appropriately named) rises to the height of about two thousand feet, the sides of which are so steep as to form an angle in many places of at least 60° with the horizon. Its summit is sharp, thorn-like and ragged, while other peaks of more rounded contour are closely piled together around and beyond it, which form, in their associated wildness of imagery, a view enrapturing to the mind of any one who appreciates and admires the romantic and beautiful in nature.

ASCUTNEY MOUNTAIN.

This mountain, belonging to the third class of the division made in this work, is situated in the south part of Windsor, and extends some distance into the town of Weathersfield. Its height, as determined by Capt. Alden Partridge, is 3320 feet above the sea.

This is an isolated mountain, standing independent of any range of mountains, and is not contiguous to any others resembling it, except Little Ascutney, and its barren and nearly naked peaks form a prominent feature in the landscape for many miles around.

Ascutney being considered a type of the granite mountains of the State, we secured a photograph of it from Miller, of Burlington, from which Plate XXXVII. was engraved. The view is from a point not far west from South Reading village. We selected this place because its conical form was more apparent than from most other points, and also for the reason that the three valleys from which the mountain is said to have taken its name are in full view upon this side.

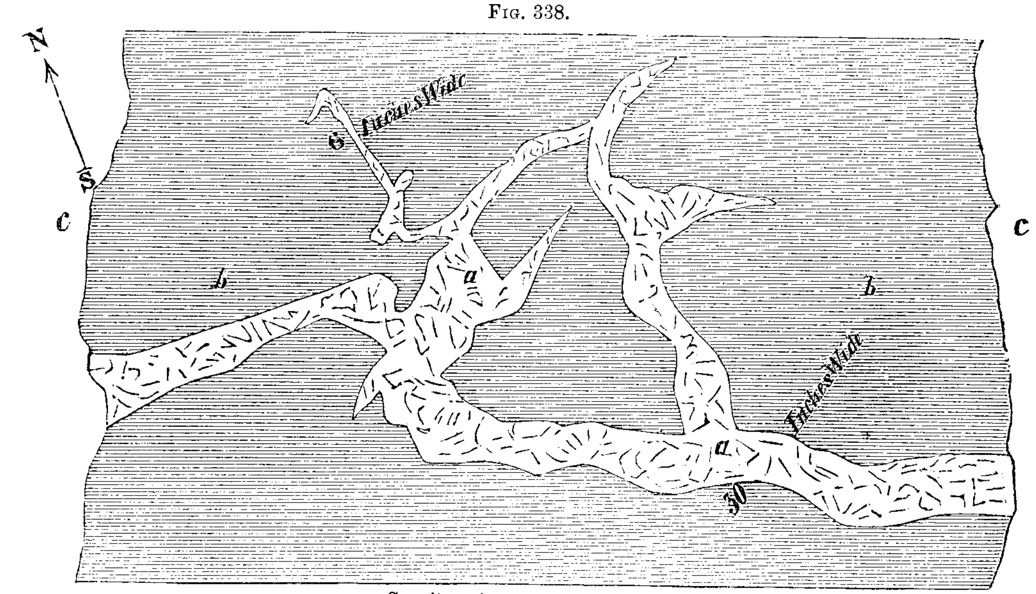
Tradition informs us that Ascutney is an Indian name, signifying "three brothers," and was applied to this mountain in consequence of the three deep valleys which resemble each other in size and course their way down its western side, from near the top quite to its base. Owing to the distance of the mountain from the place of observation, the valleys were not distinct upon the photograph, and the artist being directed alone by that, has not represented them distinctly upon the sketch. Little Ascutney is seen in this view at the right hand of the principal mountain.

The view from the top of Ascutney is probably the most extensive and charming of any in Eastern Vermont. The beautiful Connecticut, which washes its base, can be seen winding itself like a silver thread towards Long Island Sound, and the agreeable succession of farm-houses and villages, of fields and woodlands, and of hills and valleys, meets the eye from every side.

Excepting the western portion, this mountain is formed of granite and syenite, the former in many places of very coarse texture, the latter generally very fine-grained and beautiful. There is a peculiarity in the syenite in having dark patches of hornblendic rock scattered indiscriminately through it, varying in size from a kernel of corn to blotches two feet or more in diameter. These dark spots, which are very irregular in their shape, add much to the beauty of hammered specimens of the syenite; and from the fact that some of the patches are harder and others softer than the surrounding portions of the rock, there may be often seen blotches of this peculiar rock standing out in bold relief upon the weathered specimens of the syenite, while in others may be seen cavities of various forms and sizes, from which, in the lapse of ages, the softer portions have been etched out by frost and other eroding agents. Cases of the latter kind are abundant upon the western side of the mountain, near the beautiful cascade, and it was doubtless these that gave rise to the report that at this spot were found "tracks of men, horses, birds and dogs in the solid rock, shaped *just like* the foot, and sometimes six or seven inches deep."

Crystal Cascade is found where an eruptive vein of syenite cuts across "Ascutney Brook," in a quartz rock. The quartz rock west of this vein is very much cut up with joints, and a deep ravine has been made by the water of the brook and other agencies, so that a fall of sixty-seven feet, nearly perpendicular, is made by the water in passing over this barrier of syenite, affording, during the season of high water, one of the prettiest cascades in the State.

Fig. 338.



Granite veins upon Ascutney.

Explanation. — *a*, *a*, Granite veins.
b, *b*, Stratified quartz.
c, *c*, Banks of the brook, which, in this place, are about twelve feet apart.

Veins of granite and syenite are quite numerous in the quartz in the vicinity of the waterfall, some of which, by their curious contortions and branches, are quite interesting and beautiful. In the brook, about twenty rods north-east of Crystal Cascade, is an exhibition of granitic veins, of which the above is a sketch.

A good road has been constructed by the enterprising citizens of Windsor, up the north-east side of the mountain to the summit, where is also built a substantial "Tip Top House" for the accommodation of tourists. The members of the Vermont Medical Society, in 1859, held an adjourned meeting upon this mountain, at the Tip Top House. Being so near the pleasant village of Windsor—only four miles distant to the summit, with the unequaled facilities for reaching the top—this mountain will doubtless become a favorite resort for the pleasure-seeking public at no very distant day.

Many other mountains of granite occur in Eastern Vermont, and some well worthy a long description; but as this chapter is already extended beyond what was anticipated at its commencement, they will not be particularly described. In point of barrenness they are similar to Ascutney, and usually of a conical form, except when truncated as before described, or in a few cases where there is a large accumulation of drift material as in North-eastern Vermont. There is an occasional exception in point of barrenness, for when there is a superabundance of potash in the feldspar of the granite a comparatively rapid decomposition of the rock ensues, and by its disintegration there is afforded a fertile silicious soil capable of giving growth to a luxuriant vegetation. But cases of this kind may be regarded as exceptions, for the general character of soils reposing on granite uplifts is that of barrenness.

RED SANDROCK MOUNTAINS.

To the fourth division belong the series of hills found in North-western Vermont near Lake Champlain, and running nearly parallel with its eastern shore, of which Snake Mountain in Addison is a type. It is the highest one of this division, being one thousand three hundred and ten feet above the ocean. This mountain is particularly interesting to geologists, for it has been represented that upon its western escarpment were shown the edges of all the members of the lower Silurian rocks above the calciferous sandrock. Twice have we visited the mountain, and watched closely to find the favored spot from which had been sketched the interesting section of Snake Mountain found in nearly all geological works pertaining to Vermont—but in every case was the effort unsuccessful.

The ascent up the mountain upon the north, east or south sides is not difficult, but upon the western declivity the walls of rock rise so abruptly in many cases as to render the ascent impossible, except by taking zigzag lines from cliff to cliff, and drawing up oftentimes by the aid of bushes and jutting points of rock.

A short distance north of this mountain, in Waltham, is another uplift known as Buck Mountain, which rises to the height of one thousand and thirty-five feet.

About ten miles further north near the south line of Charlotte, is an elevation called Sugar Loaf or Mount Philo, which is about one thousand feet high.

Further north, in Charlotte, hills of the same class occur, called Pease Hill and Mutton Hill,* both of which rise to the height of about nine hundred feet.

The tops of all these hills are capped with red sandrock reposing upon a limestone or calcareous slate, which dip to the east at an angle of about 15° to 20°, being about the

* So called from the circumstance of a great bear hunt made upon this hill many years ago, which resulted in the death of a black sheep that had caused a grand rally of gunners who supposed bruin was in the neighborhood.

angle of elevation on the eastern slope of the hills. The western slope, as has elsewhere been remarked, is very abrupt, being not unfrequently at an angle of 40° to 65° with the horizon. Snake Hill in the north part of Milton, which has an altitude of nine hundred and twelve feet, and Cobble Hill in the south part, which has an altitude of eight hundred and twenty-seven feet, together with the series of hills extending to Canada line near the shore of the lake, belong to this class, and although the *red* rock is not invariably the cap-stone of the hills, yet the rock is evidently of the same character as the red sandrock, and undoubtedly of the same geological age.

A fact may here be repeated; namely, that the *color* of the red sandrock varies at different points, oftentimes within the space of a mile, doubtless in consequence of the presence or absence of the peroxyd of iron, which often enters largely into the composition of the rock, while at other points scarcely a trace of it appears.

Again, in the upper beds of the formation, calcareous matter is oftentimes abundant, while in the lower beds it is rarely found.

Thus it is found, by tracing closely and attentively the formation north and south, the red silicious rock that caps the hills in Chittenden County has its equivalent in a black or brown silicious limestone, not unfrequently traversed with white sparry seams, as is found on the summits of Snake and Cobble hills, in Milton, and elsewhere.

In concluding our remarks on the mountain scenery of Vermont, we will revert to the proposition made at the commencement of this article, viz., that the character of the rock determines the contour of the mountain; and we trust that such as have attentively perused the foregoing pages will feel convinced of its truthfulness.

For example: The Green Mountains, which in the southern portion are composed of a tough, crystalline, stratified rock, known as the Green Mountain gneiss, form an unbroken ridge with occasional peaks, while the northern portion, composed mainly of a softer and more easily disintegrated rock—talcose slate, with frequent interstratified masses of quartz rock—is cut asunder in several places, giving the range the appearance of mountains independent of each other. The granite hills and mountains possess usually a conical form, instead of occurring in ranges, as is usual with mountains of stratified rock, for the reason that granite disintegrates with equal facility upon every side.

Those mountains in the north-western part of the State, which we have denominated the "Red Sandrock mountains," possess a peculiarly marked outline, in consequence of the overlying quartz rock, which effectually protects the more easily worn limestones upon the eastern slope—while on the western side, where no such protection is afforded, the decomposition of the limestone has been carried on to such an extent that the softer portions, composing the base of the mountain, have been worn away, till the walls of rock in many places are nearly perpendicular.

With the hope that our efforts in this department of the Report will awaken a permanent interest in the minds of Vermonters, that shall lead them to contemplate with admiration the rich and unsurpassed beauty of our mountain scenery, we leave the subject and pass to the examination of some of the scenic beauty connected with our lakes and other interesting objects.

LAKES AND PONDS.

The beautiful picturesqueness of Vermont is not confined to its mountain scenery, but extends to other natural features, prominent among which are its numerous ponds and lakes. These, taken by themselves, have a placid feature that contrasts admirably with the pinnacled mountains that not unfrequently rise abruptly at their water's edge.

The position and extent of lakes, as well as mountains, are dependent, in a great measure, upon the geological character of the country in which they lie. Their origin is the result of three distinct causes, and hence lakes and ponds may properly be divided into three classes: First, those where the beds were formed at very remote periods, when the upheaval of the rock took place and left deeply indented fissures; secondly, those that occupy deep eroded valleys; and thirdly, those of more recent date, and not dependent upon a rock formation for their base or sides, but upon a deposit of clay or some other substance impervious to water, reposing upon a gravelly or hard pan base. A limited examination has been made of the lakes and ponds to determine the nature of their origin; and our conclusions are, that much the larger proportion of lakes and ponds belong to the second class, and occupy eroded basins.

Chipman's Pond, in the south-east part of Tinmouth, is a good example of the first class, and occupies part of a deep fissure that was formed when the rocks of that vicinity were rent asunder and tilted upon their edges. The cut upon page 771, Fig. 327, will illustrate the case in point, and show the position of ponds of this class. Assuming, as we must, that the inclined strata represented in the cut were once united and horizontal, it is evident, upon their being ruptured and tilted upon their edges, that between the severed portions there must exist a deep, yawning fissure. In this deep abyss the waters naturally collect and form a pond, as in the case named. The valley in which this pond is situated has rocks on either side of it, dipping *from* it (as in the cut) as far north as Clarendon Springs, which are on this line of fracture. Ponds and lakes of this class are usually very deep, unless streams of water empty into them, carrying in their currents sedimentary deposits that settle at the bottom and serve to fill them up.

Without attempting to discuss the cause, we will state the fact that where a limestone formation comes in contact with the crystalline rocks, there is invariably a valley, and most generally so deep as to form the basin of a lake or pond near the line of junction; and in such valleys are found the lakes and ponds of our second class.

Of this class Plymouth Pond forms a type. It is situated in a long, deep valley which, continuing from Plymouth south into Ludlow, affords beds for a series of ponds in those towns, nearly in a right line with each other, and corresponding with the strike of the rock in their vicinity. In Plymouth, the rock on the east and west of the pond is talcose slate, being conformable in dip (55° E.); and by reference to the geological map of that town (Plate XVIII.) appended to this Report, will be seen—between the talcose slate—an interstratified bed of limestone upon which the pond reposes. From an examination of the surrounding circumstances, the conclusion that the whole valley is one of erosion forces itself upon the mind. The talcose slate upon the east of the pond has, in some portions of it, large masses of interstratified quartz and quartz veins, which have effectually resisted those abrading forces, which otherwise would have worn them down. Upon the west, bordering upon the talcose slate, and not far distant from the limestone, is a bed of conglomerate quartz, compact and hard, which, with the tough Green Mountain gneiss lying upon the west of it, has resisted the eroding agencies that have so successfully scooped out the deep valley once occupied by the friable and easily worn limestone, and fitted it for the reception of water, to enliven, beautify and adorn the valley that otherwise would be dark, desolate and gloomy.

A view of this valley is given in Plate XXXVIII, taken from a point south of the lower of the two ponds. Soltudus Mountain is a prominent object in the background of the picture, and might appear to put an end to the valley in that direction. But such is not the case. By a curve in the strata at this place the valley passes up to the west of the mountain, pursuing its course upon the strata of limestone.

It is highly probable that natural ponds occur in places, as the combined result of the two agencies—upheaval and erosion; that is, where, by the dislocation of the strata, depressions were formed in the crust of the earth which has a limestone base, or one where the rock was badly shattered by the forces exerted in its upheaval; and the decomposition and disintegration have gone on so rapidly that, in the lapse of ages, ample reservoirs have been made for the reception of enough water to form lakes and ponds.

The third class of ponds in Vermont is not of the antiquity of the first two classes, and such ponds are not dependent upon rock formations for their base and sides. They date back to the period of the drift for their origin, being found in drift formations, and doubtless rest upon a basin-shaped cavity, lined with clay or some substance impervious to water. They are usually fed by deep-seated springs, and rarely have large visible outlets or inlets.

A few instances may occur where the ponds are supplied by rains and surface water, like some of the artificial ponds in Kentucky, but such cases are rare in this State. In some portions of Kentucky, and amid the clay soils of other parts of the West, where streams of living water are not abundant, the farmers are oftentimes dependent upon the water of artificial ponds for their stock. They usually select for the site of their ponds "sink-holes," which are circular depressions in the surface, tunnel-shaped, with an aperture in the rock below, through which the surface water would naturally escape. To form a pond, rubbish is usually deposited in the bottom of the "sink-hole," to serve as a frame-work to cover the rock fissure, after which corn is thrown in during the wet season, and hogs turned in to feed upon it. The continued tramp of the hogs upon the clayey soil serves to harden it and render it impervious to water, and to close the fissure at the bottom. The result is, that the rains of the ensuing wet season generally fill the basin and form a pond.

The ponds of Vermont, included in the third class, are not of the stagnant character that attaches to the artificial ponds alluded to, but their waters are usually limpid, pure and cold. Two interesting ponds of this class are found in the valley of the Connecticut River, and but a few rods from its western bank. The first to which allusion will be made is in the town of Thetford — east of Thetford Hill — on one of the terraces of the Connecticut, and elevated 140 feet above the stream. This pond has an area of about ten acres, and has no visible outlet, and lies so near the eastern escarpment of the terrace on which it is situated as to give barely room for the highway to pass between. By digging a ditch one hundred feet long and two feet deep, the water would reach the Connecticut, and being upon a loose gravel terrace, would doubtless be drained as rapidly, and in a manner similar to the famous "Runaway Pond" of Glover, a description of which is given elsewhere in this Report (pp. 729, 730) by the Rev. S. R. Hall, of Brownington.

The second pond of this class is situated on a terrace not more than ten rods distant from the Connecticut, in the town of Brunswick. Its elevation is about twenty-five feet above the river, and it has an area of twenty-five acres. It has no visible inlet, but the coldness and purity of the water in midsummer give evidence that it is constantly fed by cold springs.

An unusual and remarkable phenomenon has occurred in it three times during the last fifty years. The waters suddenly became charged with a substance destructive to animal life,—for the fish, which at times are very abundant in it, suddenly turn upon their sides and die, and the frogs, as if led by instinct, leave the scene of death, and all animated nature in it becomes extinct. The water, too, is changed in its appearance. Instead of being so transparent as to permit the vision to extend a fathom's depth, and discern fish of the smallest size, it suddenly changes to a milky whiteness, and is so turbid as to effectually hide all objects one foot beneath its surface. This scene of desolation continues only a few weeks, and the waters then resume their wonted transparency and become again the habitat of numerous members of the finny tribe.

Were we called upon to account for this singular phenomenon, we would give it as our opinion that the same agency that rendered the waters turbid caused the death of the fish. All the circumstances taken together induce us to conclude that a mineral spring having waters strongly charged with sulphureted hydrogen gas (which is destructive to animal life and renders water milky in appearance) has broken in at the times alluded to, but its passage into the pond becoming stopped, its waters subsequently pursued a different course.

Brunswick Mineral Springs are not far from this pond, and possibly their waters before reaching the surface may have entered this pond and been the cause of the desolation and unusual phenomenon.

Having treated of the three divisions into which ponds and lakes are divided, we now pass to the examination of a few of them in connection with their scenic beauties, and enter into a detail of their position and extent. Foremost in the rank will be placed

LAKE CHAMPLAIN.

This lake, on account of its size, its unsurpassed beauty, the great diversity of sublime scenery, and the historical incidents connected therewith, is one of the most interesting and attractive bodies of water in the State. A brief account of its discovery, and a few incidents connected with its history, may not be deemed ill-timed or inappropriate in this connection.

Samuel Champlain, a French nobleman, having founded the colony of Quebec in 1608, set sail in June, 1609, in a shallop, with a party of French and Indians, and proceeded up the St. Lawrence and Richlieu rivers, till stopped by the Chambly Rapids. Having a desire to push his explorations further south, he made known his wishes to his men; but

the prospect was so disheartening that only two white men could be found with nerve enough to encounter the undertaking with him. With these, and a company of about sixty Canada Indians, he pursued his explorations, transporting his canoes over the rapids and urging them up the stream, till, on the fourth day of July, 1609, the lake, to which he gave his own name, opened to his view. Aware of the hostile feelings existing between the Canada Indians and the Iroquois—in whose territory he was now traveling—he took the precaution to urge along his canoes in the lake by night and retire to the forests by day. Notwithstanding this precaution, the Iroquois became aware of the approach of the party into their domains, and a fierce and sanguinary battle was fought by the belligerent parties. The French and Canada Indians, having fire-arms, an implement of warfare never before seen by the Iroquois, the latter were put to flight with great loss. The location of this battle-field is not known with certainty, but is supposed to be near Crown Point, on what was called "Battle Point" on the early French maps.

The length of this lake is about one hundred and twenty miles, extending from Whitehall in New York, to St. Johns in Canada. Its width varies from one-fourth of a mile to thirteen miles, having an average width of about four miles, and an area of about five hundred miles, two-thirds of which is embraced in Vermont. Its depth is generally sufficient for the navigation of the largest vessels, but rarely found to be more than two hundred feet.

The southern portion of the lake, from Whitehall to the south line of Orwell, a distance of sixteen miles, is quite narrow, resembling a river in appearance, and from thence to Crown Point, about twenty-two miles, the width is from one to two miles. North of Crown Point it becomes wider, and so continues, with few exceptions, nearly to Canada line. West of Charlotte the lake is suddenly narrowed by "Split Rock," where the bold shores are only three-fourths of a mile apart.

The scenery of this lake is varied in its character, and very beautiful. To describe it would be a difficult task, for such a variety meets the eye, and such associations of historic incident crowd themselves upon the mind of him who sails upon its waters and is familiar with its history, that words fail to describe appropriately the sensations which are awakened. He beholds the beauty and wildness of the majestic Adirondacks, and fully realizes the pleasing contrast exhibited upon the opposite shores of the lake—the one rising in towering precipices, the bases of which are laved by its waters, while upon the other a comparatively level country spreads itself far to the east.

To appreciate fully the beauties pertaining to this lake, and to be inspired with the emotions produced when contemplating the acts of the patriot and others who have appeared and played their parts in the grand amphitheater of the Champlain valley, one should visit the spots hallowed by heroic acts.

In proceeding from the north end up the lake, amid those verdant islands, the traveler beholds, near the point of land known as Cumberland Head, a lighthouse; and southwest of it is seen the village of Plattsburgh, with its beautiful bay. His mind is at once directed back, through the vista of fifty years, to the time when the Saranac ran blood and Plattsburgh was the scene of slaughter.

The bay, which now bears upon its surface the richly adorned steamer with its happy inmates, then carried upon its bosom four British battle ships, under the command of

Commodore Downie, fast approaching an equal number of American vessels, manned by an inferior force, under the gallant McDonough. This naval engagement, which lasted more than two hours, resulted in the death of the Commodore and eighty-three of his men, and a surrender of the vessels into the hands of the Americans.

Simultaneous with this naval engagement there was a more fearful and sanguinary encounter upon the land. The well-drilled veterans of Britain made an attack upon the liberty-loving, though undisciplined, Green Mountain Boys and others who had hastily been gathered there, and whose numbers were numerically less than those of the enemy. For a time the battle raged with unabated fury. Finally the enemy were routed and fled in great disorder, with a loss of not less than twenty-five hundred men, while the loss of the Americans did not exceed one hundred and fifty.

Regrets may arise that men should be found at war with each other; still, no "Green Mountain Boy," familiar with its history, can sail past Cumberland Head without having awakened within him a feeling of national and State pride, when the heroic deeds of his ancestors rush upon his memory as he recalls the valorous acts of those who fought so valiantly in 1814, near this consecrated spot.

In progressing up the lake, the strongly marked outlines of Mansfield and other Green Mountain peaks raise their blue summits beyond and above the verdant headlands and thriving villages that are spread upon its eastern shore.

To specify each spot of interest along the line would enlarge our Report too much, and therefore we must be content to make a hasty passage. We cannot refrain from calling attention to the view from the lake near Clay Point, in Colchester. Our young artist-friend, Mr. Frank R. Rathbun, formerly of Winooski Falls, but now residing at Glenham, N. Y., furnished us with an admirable pencil sketch from this point, from which Plate XXVII. was lithographed. From this place most of the principal peaks of the Green Mountains, in the northern portion of the range, may be seen, as no hills of much size are near the shore to intercept the view.

The principal peak shown in the sketch is Camel's Hump, the pointed summit of which is seen towering far above the neighboring mountains.

The beautiful village of Burlington is soon reached, and the tourist who desires to look upon the most delightful scenery in New England will stop at this place; for the wildness of the Adirondacks upon one side, and the finely-marked outline of the high peaks of the Green Mountains upon the other, contrast beautifully with the fertile and highly cultivated swells of land that lie around this thriving village.

In proceeding south from Burlington, upon the lake, the prominent peaks of the Green Mountains are plainly seen, till the vision is obstructed at intervals by the uplifts of the Red Sandrock range that rises and extends south as far as Crown Point.

Upon arriving at Crown Point, unless the traveler has a map of the lake, or some guide, he will be led astray, as was Burgoyne upon his first expedition up the lake; for Bulwaga Bay has all the appearance of a continuation of the lake south, while the crooked and comparatively narrow passage on the east of Crown Point, which is the true channel, has the appearance of a small bay extending into the land only a short distance.

Crown Point and its surroundings are well worthy a visit from those who would recall the historic reminiscences of the past, and behold the ruined works of those who were actors in the grand drama. At Chimney Point, just across from the old fort in Addison, is the ground upon which the first white settlement in Western Vermont was made. It occurred in 1731, the same year in which the old French fort, called St. Frederick, was erected. In 1759 this place fell into the hands of the English, who immediately commenced the construction of a fortification upon a much larger scale, to which they gave the name of Crown Point.

The English fort was built upon higher ground than the old one, and was of a pentagonal form, and the line of inclosure, along the top of the ramparts, including the bastions, measured eight hundred and fifty-three yards. Within the inclosure were four substantial stone barracks, each two stories high, and from two to three hundred feet in length. The ramparts, which were composed mainly of stone blasted from the ditch that surrounds them, are about twenty-five feet thick at the base, and substantially built. The entire foundation is a solid rock of Chazy limestone and calciferous sandrock.

Years of hard labor and millions of dollars were expended to render these works impregnable to an enemy, and that they might command the passage of the lake at this point. Still, no trial of their strength was ever made by an assailing foe that resulted in a battle, nor were the works ever completed. They are fast going to decay. Their general plan can be seen, and many of the barrack walls are still standing, with their charred timbers, proclaiming that fire was the agent employed to aid in the destruction of these expensive but unprofitable works.

The lake south of Crown Point to Ticonderoga, a distance of fourteen miles, is from one to two miles in width. Ticonderoga, like Crown Point, is a place where immense sums of money have been lavished to render it an invulnerable fortress. Its position is very favorable for the purposes for which it has been used, being situated on a promontory of calciferous sandrock and Chazy limestone that juts out between the outlet of Lake George (Horicon) and Champlain, with natural walls of rock on the south and south-east that rise from the water's edge nearly perpendicular, to the height of from forty to eighty feet.

The French established themselves upon this peninsula in 1755, and erected, near its point, a fortress which they called Fort Carillon, the ruins of which are plainly to be seen. This fort and its favorable surroundings proved very serviceable to the French in July, 1758, when the garrison, consisting of six thousand men, was attacked by Gen. Abercrombie, with a force of sixteen thousand men. After an obstinate battle of four hours the British troops were forced to retreat, with the loss of eighteen hundred men and twenty-five hundred stands of arms. The cautious and persevering efforts of Lord Amherst, however, the next year, spread consternation through the French garrison, and on the twenty-seventh day of July the fort was dismantled and abandoned by the French, and it fell into the hands of the English troops, who took possession of it the next day.

The enterprise of enlarging the works was immediately commenced and vigorously pushed forward under the direction of Lord Amherst; and those stupendous ruins, west of the old French fort, mark the spot of the fortress, which received the name of Ticonderoga,* and which was surrendered to Ethan Allen and his Green Mountain Boys, on

*An Indian name, signifying *noisy*. So called from the falls on the outlet of Lake George.

the 10th day of May, 1775, "In the name of the Great Jehovah and the Continental Congress."

On the sixth of July, 1777, the fortress was retaken by the English, under Gen. Burgoyne, and remained in their possession till the close of the war, in 1783, since which time it has been going rapidly to decay.

The historic associations, and the beautiful scenery around Ticonderoga, render it an attractive spot, and one frequently visited by those who wish to relax their minds, for a time, from the cares and perplexities incident to active business. Were a successful effort made by the proprietors of the premises, or others, to fix and mark definitely and permanently the spots where the various historic incidents connected therewith actually occurred, it would add greatly to the interest of the place, and be far more gratifying to the visitor than to hire an ignorant guide to lead him through the catnip and Canada thistles to show him the "oven," but who was unable to tell him which of the barracks Allen entered to see La Place, for he "never heard tell of any such man."

Across the stream which forms the outlet of Lake George, in a southerly direction from Ticonderoga, is Mount Defiance—an elevation overlooking Ticonderoga, and upon which Gen. Burgoyne erected a battery when beseiging that fortress.

Mount Independence is a small elevation in Orwell, opposite Ticonderoga, upon which Gen. St. Clair erected fortifications, which were connected with Ticonderoga by a floating bridge across the lake, twelve feet wide and more than a thousand feet in length. This bridge had twenty-two sunken piers to give it strength and durability, and remains of them are now occasionally found at low water.

The sojourner at Ticonderoga must not tarry too long if he would visit all the spots of scenic and historic interest in and around Vermont. From what has been said of Lake Champlain, it is evident that the traveler may start upon his trip at the north end of it; and in proceeding south his mind is continually led back into the recorded history of the past, further and further as he proceeds. At Plattsburgh he is reminded of the bloody scenes enacted there in 1814. At Crown Point and Ticonderoga, two long strides take his mind back to the scenes of the Revolution and the Old French War, in 1754. So, too, the geologist, as he sails south through the lake, is instructed by the recorded "testimony of the rocks" that, as he advances, he is constantly passing from newer into older geological formations; for the silent testimony of the trilobite (*Triarthrus Beckii*), found in the calcareous slate so abundant on the northern banks of the lake, is, that the rocks belong to the upper and more recent members of the lower Silurian system.

Further south, at Larrabee's Point, in Shoreham, and elsewhere, he meets with the unique fossil coral (*Chætetes lycoperdon*), which claims an existence prior to that of the characteristic fossils of the Utica slate which he has left to the north of him; and proceeding further south, amid the picturesque scenery which surrounds him, his mind is led back by the light shed from the rocks, through vast cycles of time, to that period when the first dawnings of created organisms existed.

At his right hand the primitive rocks of the Adirondacks arise in majestic grandeur, and crowd close upon his path, while upon his left are abutted up against the shores of the lake the calciferous sandrock and Potsdam sandstone, bearing upon their face records of the existence of the first organic forms of the lower Silurian system.

The interest that attaches to Lake Champlain has already occupied our attention too long, and we will now turn to the attractions which cluster about

LAKE MEMPHREMAGOG.

This lake lies partly in Canada, and partly in Orleans County, Vt., between the towns of Derby and Newport. It has not the advantage of the historic and scientific interest connected with Lake Champlain, yet the legends respecting the hair-breadth escapes of smugglers, or the marvellous feats of hunters and trappers, would afford pleasure to the reader of romance. Such traditions, however, would be inappropriate in this Report.

The scenery of this lake is unsurpassed in beauty. It has become the resort of hundreds, who annually go thither during the summer months, to enjoy the exhilarating atmosphere of the lake, drink of the pure waters that flow into it, or to engage in the manly sports of fishing or hunting.

To the geological explorer this is a rare field for scientific examination and study. Here amid the great variety of rock formations may be found a fossiliferous limestone, overlaid with a formation of granite, proving conclusively the comparatively modern age of the latter. Here may be found several varieties of slate—the mica slate, clay slate, talcose slate, and the variety called novaculite, which last has been quarried and largely sold in market under the name of "*Magog Oil Stone.*" The principal quarry from whence the novaculite has been obtained is situated on a small island, about two miles north of Canada line, at the mouth of Fitch's Bay. This same vein of novaculite extends south of the lake into Newport, but has never been much quarried except at the island above named.

Lake Memphremagog is about thirty-three miles in length, and covers an area of seventy-five miles, one-fifth of which is in Vermont. It belongs to the class of lakes that occupy eroded basins. Upon examining the rock formations in this vicinity it is evident that the basin where the lake now lies was once occupied by limestone, remnants of which are found around it. Whether the agency that was exerted in rendering the talcose slate of Owl's Head so contorted and metamorphosed affected the limestone beneath it, or whether the combined influences of heat and pressure existed at the time of the protrusion of the granite that is now found amidst and overlying the limestone affected the rock so as to render it fissile, friable, and easily disintegrated, or whether from the very nature of the rock itself decomposition and disintegration resulted, we will not attempt to discuss here.

Before taking a trip upon the lake in the "Mountain Maid" steamer, the lover of the sublime should ascend Prospect Hill—south-west of, and about a mile distant from, Pendar's large and commodious "Memphremagog House," at Newport—where is an extensive landscape for miles around. From this spot our artist, Mr. Miller, of Burlington, took the photographic view from which the lithographic sketch, Plate XIX, was engraved.

To the north lies Lake Memphremagog, like a mirror reflecting its beautiful surroundings of rock and tree heavenward, with verdant headlands jutting into it, and islands dotted upon its placid face. To the left of it Owl's Head is seen towering to the height of 2749 feet above the lake, and crowding close upon its western margin as if to invite the tourist to ascend its rugged sides and from its summit view its picturesque surroundings. To the south-east from this point of observation—across and beyond the bay into which the Barton, Clyde, and Black rivers empty their waters—may be seen a lovely landscape, with the strongly marked outlines of Pisgah and Hor that rise up abruptly and mark the spot where Willoughby Lake is located. To the south no mountains intervene to cut off the view, but the eye ranges over gentle eminences that in the dim distance rise above each other, and there is outspread a broad area of country, which, with proper culture and development, may become the Eden of Vermont. To the west the country is more broken, and Jay Peak is seen, with its spine-shaped summit,—from which extends, both north and south, the ridges of the Green Mountain range.

A trip upon the lake will well repay the tourist, especially should he, like us, secure a passage upon the "Mountain Maid," commanded by Captain Fogg. The water of this lake is remarkably pure, and no stagnant bays surround it.

Province Island, through which the line separating Canada from Vermont passes, is a long, low island, which is soon reached and passed by the boat. Upon reaching this spot perpendicular and apparently narrow fissures are seen running far down from the summit of Owl's Head, completely severing the top.

Passing on and admiring the beauty of the scenery, and speculating upon the probable width of the deep fissure on the top of Owl's Head, now in full view, the tourist soon discovers Mount Elephantis, or Sugar Loaf, coming slyly out from behind Owl's Head; and as the boat comes nearer to it, the striking outline of an elephant suggests the reason of its name. The mountain lies upon the west of the lake, and when viewed from the side its name should be Elephantis, but when seen from points north of it the name Sugar Loaf seems equally appropriate.

Upon the western bank high mountains raise their cone-shaped peaks, while upon the east a level country, noted for its fertility, spreads out as far as the eye can reach.

WILLOUGHBY LAKE.

As will be seen, by referring to Plates XX. and XXII, this beautiful expanse of water lies between two mountains; the one on the east called Mount Pisgah, and upon the west Mount Hor.

Pisgah, the highest peak, is, according to a barometrical measurement which we made on the sixteenth day of August, 1860, 2638 feet above the lake, and nearly 3800 feet above tide water. The view from the summit is wild, picturesque, and beautiful. To the south lies the land of promise in Vermont, and the openings in the forest, and occasional farm-houses that dot the landscape, give evidence that the work of developing this valuable portion of the State is already commenced.

Those who have looked from mountain tops know that the country around generally assumes the appearance of a basin, but the view south from Pisgah is eminently beautiful in this respect. No prominent mountains occur in the south, but moderate swells succeed each other as far as the eye can reach in that direction. The White Mountains upon the east, and the Green Mountains upon the west, form the sides of the outspread valley.

From Killington to Jay Peak the principal summits in the Green Mountain range may be seen and recognized.

From Bemis' Observatory—a name which we applied to an overhanging ledge upon the western side of the mountain, near its top—a person who has the nerve to stand and look down 2500 feet, may see nearly the entire length of the lake and note its boundaries. From this place the observer will become satisfied of the purity and transparency of the water; for with a favorable light the pebbles and billets of wood upon the bottom of the lake, even in deep water, can be seen as if lying upon dry land. Where the mountains crowd closely upon the lake the water is said to be several hundred feet deep, but in the wider portions of the valley—especially near the northern part—it is more shallow. On the margin of the shallow portions of the lake are *walls*, composed principally of granite bowlders and pebbles. In some places they are so uniform and well proportioned as to appear like artificial structures. We incline to the opinion, however, that the expansive power of ice has collected the material in these walls from the bottom of the lake.

It is not difficult to understand how the bowlders, which once were probably abundant there, may have become partially imbedded in the ice in the shallow water, and gradually been pushed towards the shore, upon reaching which they were piled up into a wall, as now seen there and at other similar situations in the State.

These walls upon the northern shores of Willoughby Lake are in some places five feet high and eight or ten feet thick, and well worthy a visit from the tourist.

At present the shallow portions of the lake are smooth and generally covered with white sand, which has resulted from the disintegration of granite. In consequence of its bold and romantic scenery and interesting surroundings, this lake is becoming a place of great resort; and to the student in geology, who has a desire to trace out the agencies that have been at work to produce such stupendous exhibitions, no better field for contemplation is presented.

Although Lakes Champlain, Memphremagog and Willoughby differ in appearance as well as in their rocky surroundings, yet we place them in the same class, and refer them to the same origin—disintegration and erosion. They extend in line with the strata, nearly north and south; and the first two occupy basins where fossiliferous limestone comes in contact with granitic or highly metamorphosed rock.

Willoughby Lake lies between two outcrops of granite that form precipitous walls upon either side, and the bed of the lake doubtless occupies the space once filled by calcareous mica schist, or silicious limestone.

North-westerly and south-easterly from the lake, and in a line with the rock strata of the schist in the vicinity, are large quantities of silicious limestone, rendered impure by sulphuret of iron. At this place undisputable evidence exists that the schists and limestone beds are older than the granite, among which is the circumstance of granitic veins cutting across the strata of schist.

Another proof of the recent origin of the granite is, that imbedded fragments of schist are found in it, which have been detached from their parent ledge and enveloped by the granite when the latter was in a plastic state. In many instances such fragments are found, while in others the schist is weathered out and the deep nidus in which it once lay is the only record left of its former existence.

Reasoning from analogy, we may conclude that the same agencies which would affect the imbedded schist and cause it to crumble, would also produce similar results upon the strata intervening between the two outcrops of granite, known as Mount Pisgah and Mount Hor, which approach within a mile of each other on either side of Willoughby Lake. This seems to furnish, in our view, a solution to the question concerning the origin of Willoughby Lake.

If, as we have seen north and south of the lake, the strata between Pisgah and Hor consisted of an impure limestone in which the sulphuret of iron was abundantly disseminated, it seems reasonable to suppose that the protrusion of these huge masses of granite, even if the heat were not intense, would so affect the sulphuret in the rock as to produce a partial combustion, which in its turn would so affect the calcareous rock as to render it fissile or pulverulent. Being thus affected by the granite and ready to crumble by its own decomposition, it might reasonably be expected that there would be an unfathomed bed to the lake, which should occupy the space made by those powerful northern currents which during the drift period rushed with impetuous force through this deep gorge, and washed out this partially decomposed rock. In no portion of the State are there stronger evidences of a powerful drift current, than in the vicinity of Willoughby Lake. The granite outcrops, which were more unyielding than the schists and limestone, were not worn down, but stood up as barriers, and deflected the current out of its onward course through the neighboring valley. To this may be attributed, in a great degree, the origin of Willoughby Lake and the occurrence of the numerous deep gorges in that portion of Vermont.

The rusty appearance of the walls of rock on either side of Willoughby Lake furnishes evidence to sustain our theory. The legitimate result of the decomposition of the sulphurets is the production of the oxyd of iron, and wherever remaining fragments of the schist or silicious limestone exist in the granite, there is invariably a rusty tarnish upon the rock below and around them.

When admiring the beauties of Willoughby, our mind involuntarily passes back through the vista of the remote past, and receives increased delight in contemplating the mighty changes that have been wrought in this romantic spot, and we have thrown out these few suggestions with the hope that others may, like us, be equally interested in this investigation.

Without attempting a further description or detail of more of the natural lakes or ponds, we will present a list, giving the names of the principal ones not already described, with their situation and approximate size in miles and decimal parts:

	Miles long.	Miles wide.		Miles long.	Miles wide.
Allen's Pond, Marlboro,	2.50	.75	Caspian Lake, Greensboro,	3 00	1.50
Austin Lake, Poultney and Wells,	5.00	1.50	Chandler Pond, Wheelock,	1.00	.75
Barnard Lake, Barnard,	1.00	.50	Colchester Pond, Colchester,	.75	.50
Belle Water Pond, Barton,	3.00	1.50	Cole's Pond, Walden,	.75	.50
Beebee's Pond, Hubbardton,	1.00	.75	Dunmore Lake, Salisbury,	4.00	.75
Berlin Pond, Berlin,	2.00	.50	Derby Pond, Derby,	1.25	.50
Black River Pond, Ludlow,	1.50	.50	Derry Pond, Derry,	2.00	.75
Bombazine Lake, Castleton,	8.00	2.50	East Long Pond, Woodbury,	2.00	.75
Bristol Pond, Bristol,	1.50	.75	Echo Pond, Charlestown,	2.00	.50

	Miles Long.	Miles wide.		Miles long.	Miles wide.
Elligo Pond (Great), Craftsbury,	2.00	.50	Long Pond, Milton,	1.00	.50
Elligo Pond (Little), Greensboro,	.75	.50	Metcalf's Pond, Fletcher,	1.25	.25
Elmore Pond, Elmore,	1.25	.50	Miles' Pond, Concord,	2.00	.75
Fairlee Lake, Fairlee,	2.00	.75	Molly's Pond, Cabot,	1.00	.25
Fairfield Pond, Fairfield,	2.00	.75	Maidstone Lake, Maidstone,	6.00	1.50
Franklin Pond, Franklin,	2.50	1.00	Martin's Pond, Benson,	2.00	2.00
Fox Pond, Wallingford,	.75	.50	Monkton Pond, Monkton,	1.00	.75
Gillet's Pond, Richmond,	1.00	.50	Neal's Pond, Lunenburgh,	2.00	1.50
Great Averill Pond, Averill,	4.00	1.50	Nigger Head Pond, Marshfield,	1.50	1.00
Haystack Pond, Wilmington,	1.50	.50	Norton Pond, Norton,	4.00	.75
Hall's Pond, Concord,	1.00	.25	Onion River Pond, Peacham,	1.00	1.00
Holland Pond, Holland,	1.00	.50	Pensioner's Pond, Charlestown,	1.25	.50
Hortentia Lake, Hubbardton,	3.00	.50	Plymouth Pond, Plymouth,	2.00	.75
Hosmer's Pond, Craftsbury,	3.00	1.00	Runaway Pond, Glover,	1.50	.50
Hinesburgh Pond, Hinesburgh,	1.00	.50	Seymour Lake, Morgan,	6.00	.50
Holman's Pond, Stratton,	1.00	.50	Salem Pond, Salem (both),	6.00	.75
Harvey's Pond, Barnet,	1.50	.50	Stiles' Pond, Waterford,	1.00	.75
Island Pond, Brighton,	2.00	1.00	Spectacle Pond, Wallingford,	2.00	1.00
Jackson's Pond, Mount Holly,	1.00	.50	Sucker Pond, Stamford,	1.00	1.00
Joe's Pond, Cabot,	3.00	.75	Spectacle Pond, Brighton,	1.00	.50
Jones' Pond, Stratton,	1.00	.50	Trout Pond, Sutton,	.75	.50
Long Pond, Greensboro,	2.00	1.00	Tinmouth Pond, Tinmouth,	1.00	.50
Little Averill Pond, Averill,	2.00	1.00	Wells River Pond, Groton,	3.00	.75
Little Pond, Wells,	1.00	.50	West Long Pond, Woodbury,	1.50	.50
Lyford Pond, Walden,	.50	.50			

This enumeration of lakes and ponds, which we know to be imperfect by not embracing all in the State, will furnish evidence to the tourist that Vermont is well supplied with these natural bodies of water, that not only add brilliancy and beauty to the landscape, but afford fine opportunities for fishing.

Many of the most interesting lakes and ponds are in remote and unfrequented portions, which, perhaps, the tourist would not be induced to visit, if attention were called to their peculiar points of interest. But aside from these there are numerous other interesting objects which the traveler may observe as he travels through the State, to which a brief allusion will be made; and, instead of dividing our subjects regularly, and placing each portion under special classes of river, lake, or mountain scenery, we will take a hasty trip over the principal lines of thoroughfare in the State, and note some of the objects of interest along the routes.

There are nine railroads in operation within the limits of Vermont. These are four hundred and fifty-three miles in length; and the traveler, availing himself of their advantages, is often delighted with the beauty and sublimity of the scenery amid which he passes. As many of these railroads ascend the river valleys, it is as appropriate to point out a portion of their scenic beauties as they occur along the line of the road, as to attempt a description of them in connection with river scenery. It is our purpose to present in this portion of the Report a brief and rapid narrative of the objects of interest on the lines of the several railroads, as they are presented to the eye of the tourist.

THE CONNECTICUT AND PASSUMPSIC RIVERS RAILROAD.

This railroad was incorporated Nov. 10, 1835; act of incorporation revived Oct. 31, 1843, "With right to construct a railroad from some point on the southern boundary of the State of Vermont, up the valleys of the Connecticut and Passumpsic, to the north line of the State, in the town of Derby or Newport." This road was originally located for a distance of one hundred and ten miles, and is already partially built, being now open for travel from White River Junction to Barton, a distance of ninety-one miles. So great and varied are the objects of interest on the line of the road, that we are justified in pointing them out in a brief manner for the benefit of the traveler.

Upon leaving White River Junction for the north, the tourist finds himself upon the second terrace from the Connecticut, at an elevation of thirty feet above the stream. The terraced hills that rise abruptly from the western side of the railroad and hide the view from the west, gradually recede upon approaching Norwich station, and the tortuous course of Blood Brook, with its terraced banks, can be traced up the valley to the west. Norwich village, the seat of Norwich University, and Hanover upon the opposite side, the seat of "Old Dartmouth," are both hidden from the eye of the traveler, being about three-fourths of a mile from the river. A short distance north of the station at Norwich a railroad "cut" is made through a refractory rock, which we shall denominate indurated talcose slate, for want of a better name. Several outcrops of this occur, and rise abruptly near the road upon the west. Further north the rock assumes a regularly stratified character, and in appearance approaches gneiss.

An agreeable alternation of rock and terrace formations, with occasional level spots of land extending up the valley of a brook, continue till the mouth of Ompompanusac River is reached, when there is revealed to the eye a beautiful and fertile valley, in which once grew luxuriantly the wild onions that suggested to the aborigines the name since applied to the stream.

But, in going north from the Ompompanusac station, the view from the west is ever and anon cut off by the high and encroaching terraces that exist upon the west; and to the east, across the river, the country assumes a more hilly appearance, and the observer is perplexed in trying to determine whether the rounded elevations that are piled together in such profusion are the result of upheavals and erosions, or were deposited through the agency of water. To the tourist who cares not to investigate the *modus operandi* by which nature perfects her work, these vexed questions never come; and he beholds in the beautiful succession of rounded hill-tops and deep gorges all the beauties of nature for which his appetite has a relish.

Thetford station is next reached; but the pleasant village in which the academy is located is on "the hill," about a mile distant to the west. In going north the slate hills show their pine-clad summits and gradually approach the railroad, till near North Thetford, where the road runs near their base. To the left, in the dense wood that clothes the eastern slope of these slate hills, there may be seen apparently a fissure in the forest, which marks the spot where the road is located that leads to the "Howard slate quarry," situated upon the hill-side, where is seen the larger opening among the trees.

Fairlee station is next reached, just north of which are seen the hills of metamorphic rock, that stand proudly up and present a mural face, not unlike the far-famed palisades of Hudson River. At the base of these towering cliffs exists an immense amount of *debris* that has accumulated during the vast cycles of time that have rolled round since the upheaval of these rocky hills. Presently the hills grow more numerous, and encroach upon the river banks; and when about a mile below where Bradford village stands, a towering cliff extends from the west, near the river's western edge, presenting on the east a perpendicular face; and across the river a swelling knob encroaches close upon the river. These two hills, if we conjecture right, were once united and formed the southern barrier of a chain of lakes, in the dry beds of which the pleasant villages of Bradford and Newbury are now embosomed.

The traveler, upon entering this great basin, has a more extended view of the country around him than has before been presented. Terrace upon terrace arise upon the sides, some of which are very high; as, for example, the one upon which the town clock of Bradford village stands. Fertile and extensive meadows are spread out amid the curves of the Connecticut, beyond which are seen extended mountain ranges and numerous towering peaks, prominent among which, to the north-east, in New Hampshire, are seen Sugar Loaf Mountain, with its cone-shaped top, and to the right of it the sharp-backed "Moosilauke Mountain," with its steep and rugged sides, and rising to the height of about four thousand feet.

To the west are seen the thriving villages of Bradford and Newbury, both of which are situated on broad terraces, the latter at an elevation of about one hundred feet above the river. At the northern terminus of the terrace upon which Newbury stands, there is an outcrop of metamorphic slate rock, which seems to have protected the terrace south of it. The theory that suggests itself is this: that when Sawyer Mountain, south-east of Bradford, extended across the river, and formed the lakes before alluded to, the basin became partially filled with the material that was brought thither by the current of the stream emptying into it from the north. But, upon the removal of the southern barrier, the lake became drained, and the stream from the north gradually cut through and removed a portion of the lacustrine deposit; and but for the ledge of rocks alluded to, the whole might have been swept away. The water in its course south struck against the rocks, and being deflected out of its course swept by in eddying currents, removing the loose material that came within its range. Harriman's Brook, that came in from the west through the valley north of Mount Pulaski, also cut a channel through the lake bed, and formed the valley in which the railroad station is now situated.

We have already spent so much time in looking at the terraces around Newbury, that it will be best to "stop over one train" and see other objects of interest in the vicinity. Should the traveler have a desire to behold a beautiful landscape, he can ascend Mount Pulaski, which rises abruptly at the western part of the village, to the height of three hundred and eighty-four feet above the street, and from its summit behold in the panorama outspread before him,— the village stretching north and south, with its tasteful dwellings gleaming in whiteness amid the thrifty shade trees of the street, beyond which extensive river bottoms are spread out, ready to receive the fertilizing elements borne thither upon the bosom of the Connecticut that winds in graceful curves around the fertile headlands. Far to the north, in the valley, the curved and silvery lines of the Connecticut may be seen, and to the right of them the blue outlines of the Franconia Mountains terminate the view in that direction. About ten miles distant to the east from Pulaski, Moosilauke Mountain is a prominent figure in the mountain scenery that forms the background of the picture. But perchance the traveler may be an invalid, and if so, he may defer his visit to the summit of Pulaski, till he shall have regained his health by using the strongly charged chalybeate waters found at the "Sulphur Springs" of Newbury. These springs are a favorite resort for invalids, and doubtless are efficacious in the removal of cutaneous diseases.

But the whistle from the iron horse admonishes us that the up train is approaching the station, and soon he is seen emerging from the tunnel that passes through the narrow arm of the terrace north of the village. Once more upon the cars, that upon this road run so smoothly as to permit us to write as we ride, we look out to the east upon the rich meadows included in the "Great Ox Bow," and soon are borne to Wells River village, the terminus of the White Mountain railroad, which is distant thirty-two miles from the White Mountains. McIndoe's Falls in the Connecticut River, four miles further north, in addition to the facilities they afford to the manufacturer are quite pleasing to the eye of the traveler.

Barnet is next reached, and at this place the railroad leaves the lovely and fertile valley of the Connecticut, and shoots into the vale of the tortuous Passumpsic, amid scenes of wild and picturesque beauty, quite pleasing to the eye of the tourist.

St. Johnsbury is the first place of importance met with on this road, and here the traveler should stop if he would see a thriving village. It contains about three thousand inhabitants, and as an evidence of its thrift, it may be said that every dwelling in it is painted. No rude shanties are found in its backgrounds,—but instead of them, in the western outskirts, have sprung up the splendid manufactories, dwellings and out-houses, where are made the celebrated "Platform Scales" of the FAIRBANKS. These scales have gained a world-wide celebrity for their accuracy, and the many humane and benevolent acts of the brothers Fairbanks—not alone in the "rich donations" for benevolent objects, but the fraternal solicitude which they ever manifest toward the worthy mechanic in their employ, have won for them a reputation more elevated and enduring than the immense profits realized from the sales of their scales. St. Johnsbury village is on a terrace, the main street of which is one hundred and forty feet above the Passumpsic River.

Upon leaving St. Johnsbury for the north, the valley of the Passumpsic grows narrower and the stream more winding, and the tourist is impressed with the truth that he is in a comparatively new country. Lyndon is soon seen at the west, and after passing along through the valley of a small tributary of the Passumpsic, the train shoots off from the valley and arrives at West Burke—the summit of the road between New York and Quebec—where stages are in readiness to take passengers to Willoughby Lake (five miles distant.) Soon the cars ascend to the north, and after winding along the western bank of Bell Water Pond for three miles, Barton is reached, which at present (November 1861) is the northern terminus of the road, and fifteen miles from Memphremagog Lake—a favorite resort for the tourist, and which is described elsewhere in this Report (p. 903.)

From this terminus the tourist is conveyed through picturesque scenery by stages to Newport, at the head of Lake Memphremagog. During the summer season a little steamer called the "Mountain Maid" plies between Newport and Magog, the outlet of the lake, where daily communication is established between that point and the railway which carries the tourist to Montreal and Quebec.

THE VERMONT CENTRAL RAILROAD.

This railroad company was incorporated November 1, 1843, for the purpose, and with the right, of building a railroad "from some point on the eastern shore of Lake Champlain, thence up the valley of Onion River, and extending to a point on Connecticut (river) most convenient to meet a railroad either from Concord, New Hampshire, or Fitchburgh, Massachusetts."

This road is located in the valleys of the Winooski, the Connecticut and White rivers. It commences at Windsor, and follows the last mentioned stream from its mouth to the source of its third branch; thence, reaching the summit in Roxbury, and passing down the valley of Dog River, it enters the Winooski valley near Montpelier; and thence, continuing in the Winooski valley, its terminus is reached at Burlington, a distance of one hundred and seventeen miles.

Located in these fertile and picturesque valleys, a trip over it by one fond of contemplating the sublime and beautiful in nature, will not fail to be rewarded with constant and ever varying pleasure.

Before leaving Windsor, the tourist should visit Ascutney Mountain, and from that huge pile of granite behold the enchanting landscape spread out around him. Having from its summit taken a more extended view of the densely populated portions of Vermont than is elsewhere afforded, and traced the winding of the railroad up the valleys of the Connecticut and White Rivers, he may descend to the terraced village of Windsor; and having embarked at its spacious depot, he is at once ushered into a fertile portion of the Connecticut River valley. Highly cultivated farms and substantial farm-houses break suddenly upon his view from every side.

Upon reaching the south line of Hartland, Lull's Brook is seen coursing its way down a narrow valley; and within full view from the cars is a beautiful water-fall, made by its passage over the hard and unyielding hornblende rock, from which it leaps into a deep ravine that passes under the railroad.

After passing Hartland the aspect of the country becomes changed. Instead of the rich alluvial bottoms, high gravelly terraces with lighter soil are seen, upon which pine trees abound. These terraces and jutting points of rock so closely crowd upon the stream, that cuts are made through them for the passage of the cars.

Passing North Hartland the tourist is soon brought to the valley of the Quechee River, where it has broken through its barrier of indurated talcose slate in its course to the Connecticut River. This spot should attract the special notice of the tourist; for as the cars pass the bridge over a deep gorge, a beautiful water-fall is seen where the stream leaps over its rocky barrier, in a nearly perpendicular descent of about fifteen feet, the sheet being broken, like Niagara, by the interposition of a rocky islet that extends to the very brink of the precipice. A hasty glimpse from the cars is all that can be obtained, for the traveler is soon passing by cuts and fillings upon the road, and is enabled at intervals to catch hasty views of the graceful curves of the Connecticut and the beautiful landswells that lie beyond, but is suddenly deprived of the pleasure of contemplating them, for there are soon brought to his view others equally enchanting.

Amid these rapid transitions of mingled regret and delight the traveler reaches White River Junction, where he leaves the Connecticut and enters the fertile and highly cultivated valley of White River. At this place, as universally in Vermont where two streams meet in a wide-spread basin, terraces of various heights and extensive range are found. Upon the top of one of these terraces at an elevation of over 120 feet above the Connecticut River is a pond covering several acres, possessing no visible inlet, but belonging to the third class of ponds described in another part of this Report. Pond lilies abound, and their roots form a strong net-work capable of sustaining the weight of a man.

Vegetable matter has accumulated upon these roots to a considerable depth, and in spots cranberries, alders and other shrubs grow luxuriantly. A person may safely walk several rods from what was evidently the original shore of the pond. As he walks, however, there is communicated to the ground upon which he treads a wave-like motion that visibly extends in every direction. Here the traveler may notice the process by which the jelly-like accumulations of matter, often met in swampy grounds, were formed. If the agencies now at work are not molested, a film of vegetable matter will ultimately extend over the entire surface of the pond, and afford a congenial spot for plants of larger growth, and in due time an extensive swamp will usurp the place now occupied by this pond.

Leaving White River Junction, the traveler passes up the valley of White River, and becomes favorably impressed with the proofs of thrift, and the commendable enterprise visible upon his entire route. Thriving villages, comfortable and often elegant farm-houses, and highly cultivated fields, break in upon his view as he swiftly glides through the towns of Hartford, Sharon, Royalton and Randolph, all of which are excellent farming towns. The richness of their soil results in a great measure from the decomposition and disintegration of the impure limestone, which is quite abundantly disseminated in this portion of Vermont.

Upon reaching the talcose slate in Braintree, the soil and general aspect of the country suddenly becomes changed. Instead of the beautifully rounded hills which afford a soil capable of sustaining a luxuriant growth of vegetation by reason of the rapid disintegration of the rock forming their bases, the unyielding talcose slate forms hills with pinnacled summits upon which the vegetation is more stinted.

To the tourist, the change from the beautiful farming country of the calcareous rock formation to the broken and picturesque region in the vicinity of the highly crystalline rocks of the Green Mountain range is attended with greatly increased delight. The high shelving rock, the narrow and steep-sided valley, the towering peaks of the Green Mountains and the general wildness of the scenery amid which he passes, combine to give unmeasured beauty and sublime grandeur to the landscape.

The tourist passes on through the deep dells of the mountains, till he reaches Roxbury summit. In passing through this gorge, the two streams are found to proceed from the same swamp, or from springs not far from each other. The head waters of White River

are hardly lost sight of before those of Dog River are seen running in an opposite direction. This is a noticeable fact in most of the deep gorges in Vermont. Near Roxbury summit lies the quarry of the American Verd-antique Marble Company, in full view, and upon the left of the railroad track. A steam mill, around which are numerous slabs of marble, is situated near the railroad.

The tourist's attention is attracted towards the thriving villages of Northfield, and especially of that part of the town in which the large station house and car works are located. Everything here will recall to his mind the labors of that far-seeing and energetic man who was the projector of the railway which passes through the central part of Vermont, and whose remains lie buried upon an eminence in the cemetery at Northfield, at whose base runs the railroad with which his name will ever be associated. If the traveler visit that beautiful cemetery, his attention will be arrested by a high and tasteful monument, upon which is inscribed, in just and elegant terms, the following epitaph:

CHARLES PAINE

Son of Hon. Elijah and Mrs. Sarah Paine
For two successive years
Governor of Vermont.

**Happy in his Parentage, a youth of preparation
Was followed by an early maturity of usefulness
Invigorated by many virtues and adorned by many
Manly Graces.
Devoted to his Native State, he applied his talents
His wealth and his strength to the advancement of
Her great Public Works and the encouragement of
Her Institutions of Learning.**

**Having bestowed upon Vermont benefits of which
the value cannot yet be justly appreciated, he
considered the wants of the World and the Age;
and while seeking a path which should unite
the Atlantic and Pacific coasts he died in a distant
land, far from those who loved him.**

**Having merited well of the commonwealth and
His kind, his remains were here interred, hallowed
by Public Honors and private tears.**

**Born at Williamstown, Vt., April 15, 1799;
Died at Waco, Texas, July 5, 1853.**

Bidding a reluctant farewell to the busy manufacturing villages of Northfield, which are passed in rapid succession, the traveler soon finds himself in Berlin, at the "Montpelier Junction," so called.

The traveler cannot fail to be favorably impressed with the character of the people of Montpelier, as he goes from the Junction to the capital of the State, and observes the public spirit and excellent taste displayed at Green Mount Cemetery. As he approaches the village of Montpelier he finds that the resting places of the dead are not alone the recipients of the well-directed efforts of a refined taste, but the tasteful and hospitable residences of the living, and the public edifices of the capital, have also an impress of the beautiful and elegant stamped upon them.

Next to the State House, which is a masterpiece of architectural and artistic skill, we must rank the Union School House, which is a stately edifice, finished in the highest style of art, and of the most approved pattern, and one of the largest and most commodious buildings of the kind in Vermont.

In addition to the varied attractions afforded in the village, there are many points of interest to the lover of nature in the beautiful surroundings of the town. Not only are the terraces interesting in a scientific point of view, when we contemplate the changes wrought upon them since their deposit by the united waters of the Winooski and North Branch, but their level tops and gracefully sloping sides are pleasant to the eye. Those who like a more picturesque scene must take a drive about three miles east towards Barre, and follow up the stream that conveys the water of Berlin Pond to the Winooski River.

Several cascades of unsurpassed beauty are found in the distance of a mile, either of which near some place of fashionable resort would be deemed worthy of a special visit.—Mr. Frank F. Currier, an artist in Montpelier, fully appreciating the beauty of these splendid waterfalls, has secured some fine stereoscopic views of them, which he offers for sale. To describe these falls particularly, and portray in a fitting manner the grandeur and enchantment that surrounds them would require a magic pen, and occupy more space than we can appropriate to the description of this hasty trip upon the Central Railroad. We can, therefore, merely add that within the distance of a mile there is a descent of the sheet of water forming this stream of about 200 feet, over the ragged rocks that form the steep sides of the valley.

The tourist, resuming his place in the cars, observes at the Junction a moderately broken country with fertile intervals in the valley of the Winooski, down which the road extends to Burlington. Round-topped terraces, and water-worn ledges are seen in rapid succession, crowding closely upon the river banks, and oftentimes their projecting points are cut in twain to furnish a place for the railroad to pass.

At Middlesex the Winooski passes over the craggy bed-rock, forming valuable rapids for a water power, and a beautiful landscape to look upon from the cars. Here is a spot of interest to the geologist, for he sees unmistakable evidence that the channel of the Winooski was once north of the spot where it now runs. High terraces are abundant, and the rocky barrier through which the Winooski has worn its deep channel once turned the stream to the north, and its course was continued out of the present valley as far west as where Waterbury now stands.

Middlesex Narrows is the name applied to the deep gorge through which the waters of the Winooski flow below the rapids,—and being an excellent example of erosion and quite picturesque, we have given a view of it (Plate XXX.) engraved from a photograph by Mr. A. F. Styles, of Burlington.

Passing westerly from Middlesex, the traveler becomes conscious that he is approaching the Green Mountain range, for the strongly marked outline of Camel's Hump is seen peering far above the neighboring summits, and the high hills crowd more closely upon the Winooski River than in the more easterly towns just passed. The thriving village of Waterbury is soon reached, where commodious stages are in readiness to convey passengers through a pleasant country to Stowe, a village eight miles from the summit of Mansfield Mountain.

Bolton Falls are well worth visiting, and they lie but a few miles below Waterbury, on the Winooski. Here is a wonderful evidence of the mighty agency of water; for an ordinary observer cannot fail to discover that the high bluffs of rock on either side were once united, and formed a barrier through which the stream has gradually worn its deep and narrow channel. The contemplative mind at once reverts back to the time when this barrier existed, and beholds a long and narrow lake extending up the valley to Montpelier, and discovers the reason why the streams emptying into the head of this lake should, in the still water, deposit the sediment forming the numerous terraces near that attractive village. The same reasoning may be applied to the terraces near Waterbury village. In the tranquil waters of this lake the sediment brought down in the floods by Waterbury Branch, and other streams emptying into this body of water, would settle at the bottom and partially fill it. Upon the opening of the rocky barrier—like the breaking away of a flume or a portion of the dam to a mill-pond partly filled with sediment, the running stream would sweep down a portion of this sediment by cutting a channel through it, either in the center, leaving portions at each side; or upon one side and leaving the other remaining, as at Waterbury, where the principal terraces, or remaining portions of what once partially filled the lake, are found upon the northern portion of the stream.

The highest peaks of the Green Mountains are nearly in line with Bolton Falls and but a few miles distant from them. Perpendicular and overhanging rocks form the high walls of the gorge, and huge bowlders piled together nearly bridge the channel at low water. A short distance below the falls the traveler may look from the cars and see the outlet through which the foamy stream escapes, and behold far above it the jutting rocks that form the sides of that deep and dark abyss.

"Ridley's Station" next is reached, where tourists to Camel's Hump can be well accommodated with conveniences to reach the summit. The aspect of the country in this vicinity is such as to impress the traveler with the fact that he is *near* a mountainous region. He can, however, hardly comprehend the fact that he is going through a gap about four thousand feet below the summit of Mansfield Mountain and Camel's Hump that are situated on either side of him and but a few miles distant, and that he is less than three hundred and fifty feet above tide water.

The smoothly rounded rocks that project from the sides of the valley, as well as the striated ones near the bed of the Winooski, bear unmistakable testimony that by some abrading agency, in which water played a conspicuous part, the rocks have been worn down so as to give greater width to the valley. No spot shows this more clearly than where the valley narrows east of Jonesville. Not far from the hotel, in Jonesville, in full view from the cars, is a beautiful cascade with a pinnacled rock rising high near the side of it, and with such other wild surroundings as to render the spot very picturesque.

Before reaching Richmond Station an extended valley is spread out, and beautifully rounded hill-tops apprise the traveler that he is leaving the unyielding crystalline rocks of the Green Mountains and approaching a portion of Vermont which is underlaid by those that are unable to withstand the prolonged attacks made upon them by atmospheric agencies, but have crumbled and help to form the soil which is so fertile in their vicinity.

Another proof that the traveler has passed *through* the mountain gorge is, that upon looking back a little to the south of east there is seen a sharp pointed peak which he at once recognizes as Camel's Hump, standing in its solitary grandeur, and presenting nearly the same profile that was seen when approaching it from the east. As the cars move westward through the excellent farming town of Williston, Camel's Hump seems to rise out of its nest of mountains and become more prominent; and looking to the north-east, old Mansfield comes slyly out from behind the nearer ridges and his *man*-like face forms a strongly marked feature in the eastern landscape. Here the Forehead, Nose and Chin of the mountain are seen to good advantage, and while admiring the gigantic proportions, and estimating the length of Nose and hardness of the cheek of that upturned face, the traveler is awakened from his reverie by the announcement of the Station, which until lately was "Essex Junction—change cars," but which announcement is now varied by dropping the latter part of the sentence except when applied to those whose destination is Burlington and points further to the south.

Leaving Essex Junction for Burlington, the traveler is soon taken from the sandy table lands into the fertile and highly interesting valley of Winooski River. The width of this valley varies as the rock formations change, in proceeding across the line of strata in places spreading into broad tracts of rich intervale; and at others where the rock has proved more unyielding, the valleys are narrower, and in some instances deep gorges exist through which the river finds a passage. Beautiful exhibitions of erosion are near the limekilns of Messrs. Penniman & Noyes, where the river has cut through the beds of silicious limestone. As the tourist passes over the two railroad bridges a few rods further west, he can, from the giddy height, behold the perpendicular and overhanging walls of rock that rise on either side of the Winooski to the height of nearly one hundred feet.

A good view of these deep gorges is given on Plate XXVIII, taken from a beautiful pencil sketch made by Miss Hattie E. Read, daughter of Hon. David Read, of Colchester, who resides near this romantic spot. By referring to the Plate it will be seen that the solid rock is completely cut asunder by the river; and in the stream a high rocky island rises, crowned with fir trees, as is the sharp-pointed promontory around which the river curves, and over which the railroad passes between the two bridges.

Darting through a rock-cut, the tourist is soon taken along the fertile valley to Winooski Falls, where is afforded an excellent water power that has given rise to the thriving village of Winooski. Upon a high terrace west of the village, in Burlington Cemetery, may be seen a granite shaft—erected by the State of Vermont, in 1857—that marks the grave of *Ethan Allen*. Leaving the cars at Winooski, the tourist will pay a visit to this spot—which is in Burlington—and admire the Tuscan column, which is forty-two feet in height, and four and one-half feet in diameter at its base; having a pedestal six feet square, in which are inserted four tablets of white marble, bearing the following inscriptions:

[West Side.]

VERMONT
TO
ETHAN ALLEN
BORN
in Litchfield Ct 10th Jan A D 1737 o s
DIED
in Burlington Vt 12th Feb A D 1789
and buried near the site of this monument

[East Side.]

Taken
Prisoner in a daring attack on Montreal
and transported to England
he disarmed the purpose of his enemy
by the respect which he inspired
for the
REBELLION AND THE REBEL

[South Side.]

The
LEADER OF THE GREEN MOUNTAIN BOYS
in the surprise and capture of
TICONDEROGA
which he demanded "in the name of
the Great Jehovah and the
Continental Congress"

[North Side.]

Wielding
the Pen as well as the Sword, he was the
sagacious and intrepid
DEFENDER
of the New Hampshire Grants, and
Master Spirit
in the arduous struggle which resulted in the
Sovereignty and Independence
of this State.

The tourist will not neglect to visit the spot where the far-famed metaphysician, James Marsh, D.D., is buried, and to whose memory a beautiful and chaste memorial-stone is erected by his friends and the alumni of the University of Vermont. He will pause awhile in the old village burying-ground, and, remembering how much the Rutland and Burlington Railroad is indebted to the labors and energy of its late President, and how he lost his property, reason and life, in prosecuting that great work, will read in silence and tears the following epitaph:

TIMOTHY FOLLETT
DIED
OCTOBER 12TH 1857
AGED
64 YEARS.

Passing by the graves of the late Heman Allen, Prof. James Dean, LL.D., Dr. John Pomeroy, and the Hon. Charles Adams, the traveler's attention will be arrested by the following inscription on a white marble slab:

Rev. ZADOCK THOMPSON
DIED
JANUARY 19, 1856
AGED 59 YEARS
AND 8 MONTHS
GOD'S WILL BE DONE.

He will be reminded of the facts, that exactly three years before the death of Prof. Zadock Thompson—who was State Naturalist at the time of his decease—Prof. Charles B. Adams, the first State Geologist of Vermont, who commenced the Survey of which this is the final Report, died of fever on the 19th of January, 1853, on the island of St. Thomas, W. I., whither he had gone for scientific purposes. And standing beside the memorial-stone of this Christian gentleman, devoted naturalist and learned historian, he will regret that Prof. Thompson "entered into rest" before he was permitted to leave any permanent records of his great labors on behalf of the Geological Survey of his native State.

It is not consistent, however, with the purposes of this Report, to revive any of these interesting and sometimes painful memories, but we cannot well refrain from making mention of such names as Thompson, Follet and Paine, when we pass by their graves, and recollect the valuable service they have rendered science and the State by their indefatigable labors. Aside from the consciousness of having done their duty, and being entitled to the welcome plaudit of "well done thou good and faithful servant," how poorly have these benefactors been remunerated for their toil!

The tourist in his route through Vermont will not fail to sojourn awhile at Burlington, the termini of three important railroads—the Vermont Central, Vermont and Canada, and the Rutland and Burlington.

As respects natural advantages and beauty of location, Burlington may be called the queen village of the Champlain valley. It is situated upon high terraces that gradually slope towards the lake, and from the more elevated portions may be seen the highest peaks of the Green Mountain range.

In full view to the west is Lake Champlain, with its mirror-face dotted with Juniper Island, Rock Dunder, The Four Brothers, and numerous other small islands. Many indentations are made upon the eastern shore of the lake by the encroachment of jutting headlands, among which Pottier's Point, Appletree Point, Lonerock Point, or Sharpshins are the most conspicuous. Across the lake, which in this place is about ten miles in width, may be seen the numerous pointed summits of the Adirondack Mountains, which taken in connection with the surrounding scenery, if viewed in the glory of a sunset, or in the noonday splendor of a summer's sun, reveal to the spectator in Burlington a glow of associated beauty rarely, if ever, witnessed in any other portion of our country.

In the year 1791, Burlington became the seat of the University of Vermont, which has gradually grown into importance and influence,—and in connection with it is a new and flourishing Medical College. These, with the Vermont Episcopal Institute—a well sustained Union School and Academy—and several seminaries for the education of females, must be regarded as a fair indication of the intelligence and culture of the people of this favored village. The advantage of her beautiful and elevated position; of her great conveniences for all branches of education; of her United States Custom House and Marine Hospital; her beautiful churches and Town House; of the many and attractive private residences which are occupied by men of culture and wealth—all combine to give to Burlington a prominence among Vermont villages which time will probably increase rather than diminish.

Having given the tourist time to make a brief examination of this interesting village, we will now take a hasty trip upon

THE VERMONT AND CANADA RAILROAD.

The Vermont and Canada Railroad Company was incorporated by the General Assembly of Vermont, October 31, 1845,—amended and altered, November 15, 1847, giving a right to build a railroad "from some point in Highgate on Canada line, thence through the village of St. Albans to some point or points in Chittenden County, most convenient for meeting, at the village of Burlington, a railroad to be built on the route described in the acts to incorporate the Champlain and Connecticut River Railroad Company [subsequently, by change of corporate name, called the Rutland and Burlington Railroad Company], and the Vermont Central Railroad Company." The length of this railroad as completed from Burlington to Rouse's Point on Lake Champlain, is fifty-three miles—passing through the intermediate towns of Colchester, Milton, Georgia, St.Albans, Swanton and Alburgh.

Resuming his seat in the car, the tourist passes along the shore of the lake, at the base of a high sand terrace which rises abruptly at his right hand, and through which a tunnel has been made for the road to pass about three-fourths of a mile north of the depot in Burlington. Before reaching the tunnel, an open cut through the western portion of the terrace is made to the depth of about eighty-five feet, and twenty or thirty rods in length. To the geologist here is opened a field for investigation. In some portions of the cut are seen regularly deposited strata of sand dipping slightly towards the lake, but in others are seen contortions and plications so unique and varied in their form as to beggar description. In consequence of the compact nature of some portions of the strata, and the arenaceous character of others, the wind has removed the loose sand and left the more compact portions jutting out in bold relief, and presenting an appearance more closely resembling the fantastic handicraft of an artist than a sedimentary deposit made by water.

Above and below these curious combinations of curved strata are regularly formed beds of sand and gravel, nearly horizontal, which were unmistakably deposited by water. While gazing upon this interesting phenomenon, we were almost led to distrust many conclusions to which we had previously arrived, in relation to the cause of contortions which occur in many metamorphic rocks, for here are as complicated curves and as numerous folds as we recollect to have witnessed in any metamorphic strata.

Since the time of the deposit of the material forming this terrace, the strata have undergone no change probably, except it may be the decomposition of some portions of the deposit, and solidification of others, by the infiltration of water charged with lime or the oxyd of iron. As evidence of this, we will state that roots and small billets of wood were originally deposited with the sand, but at present only their outlines can be seen; and were it not for an incrustation of the oxyd of iron upon the bark, even the form which they once had could not now be determined.

In other places, large and thin sheets of sandstone are found intercalated with the sand, which were evidently formed by the infiltration of lime-water, and the strong affinity existing between the silex of the sand and the calcareous matter held in solution by the water.

Clay enters into the composition of much of the material forming the terrace, but is rarely found in a pure state, being generally mixed in small proportions with the sand. In excavating for the tunnel, alternations of sand and clay were occasionally encountered, especially in the lower portions.

Beneath a thin stratum of clay, at a depth of eighty feet, a live toad was found occupying a small smooth cavity in the sand. When first taken from his long occupied nest he was torpid; but, upon exposure to the air, soon showed signs of life, and was taken by Hon. H. B. Stacy and kept alive about six months. The dried skin of this antediluvian is now in the possession of this gentleman.

The tunnel, which is about three hundred and fifty feet in length, deserves a brief notice: It was built under the direction of Hon. John Gregory Smith, of St. Albans, and Joseph Clark, Esq., of Milton, the Agents of the Vermont Central and Vermont and Canada railroads, who were designated and appointed by the directors of both companies in interest. Daniel C. Linsley, Esq., had charge of the work as chief engineer.

The tunnel is of brick, except the arches at each end, which are made of black limestone. The shape of the arch is similar to that of a horse shoe, having a height of nineteen feet in the center. The greatest width is sixteen feet, which is about six feet above the track; and at the grade line it has a width of thirteen feet. The walls of the arches rest upon large blocks of limestone, which are firmly fixed in concrete about eighty-five feet below the surface of the terrace. The tunnel is not straight, but is built upon a curve, with a radius of 1432 feet. The structure displays good taste and skillful engineering, and reflects much credit upon those who had the work in charge.

Emerging from the tunnel the tourist is conducted into the lovely valley of the Winooski, and again is he permitted to enjoy another view from the high bridges that span the deep gorges before noticed.

Some of the valley passages of the Winooski River, and especially near "Hurlgate" (as it is called on the railroad maps), are scenes of great beauty, and in places it is a turbulent stream, dashing madly over stern and high precipices and through rugged defiles. The picture near the "High Bridge," where the waters rush through a wild ravine and form a beautiful cascade, is one of the most attractive in the valley of the Winooski River. We regret our inability to present more views of the scenery in this section of the Vermont and Canada Railroad, which are of great picturesque interest.

After a few miles of further travel, through a country not especially attractive, we reach Painsville, known as Essex Junction. Proceeding thence in a northerly course, the Vermont and Canada Railroad leads through a comparatively level country, but not so fertile in its character as the section east of Essex Junction. Pine plains are soon discovered, and on them remain vestiges of forests, with an occasional pine of primitive growth towering far above the surrounding trees. These pine plains are chiefly covered with small oaks, and seem particularly well suited to the culture of rye and corn.

Colchester station is soon reached and left, and the tourist, looking towards the east as he whirls rapidly along, sees, not very far distant, the strongly marked outlines of the Green Mountains. On the left, and towards the west, the country presents an appearance

somewhat uneven—extending, with occasional stream, valley, and two small ponds, to Mallett's Bay. The rivers La Moille and Winooski, Mallett's Creek and Indian Creek, with a beautiful bay on the lake, give to Colchester a very picturesque appearance, which, however, is only partially visible to the tourist who is confined to the railroad cars. The lime and slate rocks, with occasional bowlders of granite found in the northern and eastern parts of the town, have been duly noticed in other parts of this Report, as well as the beautiful Winooski marble, which is found in abundance and variety near Mallett's Bay.

As he glides along in the cars the traveler gets a glimpse of a church spire in Colchester several miles distant, and passing by the "Iron Field," or a spot in the north-eastern part of the town where hematite or the brown oxyd of iron has been found, he soon reaches the Station at Milton Falls. The township of Milton, which borders on the lake, is watered by the La Moille River—which runs through it from north-east to south-west—and by several small streams which afford good mill seats. Milton Falls lying near the railroad, and being a curiosity, ought to be visited. A description of this attractive spot, made useful as well as attractive by the excellent mill sites which have been improved by Joseph Clark, Esq., and others, is found in Thompson's History of Vermont, Part III, pp. 116, 117, and is here quoted at length:

"The Great Falls on the river [La Moille], seven miles from its mouth and a little to the south-east of the center of Milton, are a considerable curiosity. In running fifty rods the whole river falls about one hundred and fifty feet. Near the middle of the cataract is a small island, upon each side of which the water rushes down with the greatest violence, rebounding from rock to rock, tossing its spray into the air and stunning the astonished spectator by its successive concussions and incessant roar. These falls are often visited by the curious."

The surface of this township is gently diversified with hills and valleys besides two small ponds in the western part of the town, but it contains no high mountains. "Cobble Hill" in the south, and "Rattlesnake Hill" in the north part—both visible from the cars—are the most remarkable. These hills, which rise abruptly from a comparatively level country, are about 900 feet high and give a marked and pleasing feature to the landscape.

Passing rapidly along in the cars in a course parallel with, and not far distant from, the bank of the river La Moille, we reach, after traveling three and a half miles, the Georgia Station—immediately south of which the railroad crosses one of the highest, longest and most substantially built bridges in Vermont. It was built under the superintendence of Henry R. Campbell, Esq., of Burlington, well known as a capable and experienced civil engineer, and embraces three spans of 150 feet each—the whole structure of stone, wood and iron, being thoroughly finished and protected from the action of ice and frost at an expense of about $70,000, and presenting a marked contrast to the old structure of trestle-work and alternating piers whose remains are visible near by.

The scenery from this bridge will be highly gratifying to the tourist. The river La Moille passes rapidly under this admirable specimen of modern railroad bridge-building from a fall near by. Looking to the east towards Fairfax, the traveler sees a beautiful country watered by the La Moille; and to the west some interval farms which are rarely equalled in beauty and fertility, and a variety of landscape which only the skill of the best painter can fitly portray. The historical associations connected with this locality, although curious and interesting to the antiquarian, are not properly allied to this Report, and must not be alluded to. The appearance of the country from this bridge presents to the eye of the intelligent tourist a marked contrast between the luxuriant vegetation that thrives in the valleys, and that found upon the sandy uplands.

The station-house is in the southern part of Georgia, several miles distant from the villages of Georgia Center, West Georgia and Georgia Plains. Not far from it we find outcroppings of the beautiful "Winooski Marble," which is so abundant at Mallett's Bay, in Colchester. The writer hereof visited, in 1852, a railroad-cut made through a ledge near the station-house, and obtained some specimens of marble, which, in default of a better name, he then called the "Georgia Marble;" but since then he has been willing to adopt the more euphonious name which has been applied to it by his friend, the Hon. David Read, of Colchester, who was the first Vermonter who quarried and wrought it as a marble.

As the tourist proceeds northwardly from Georgia station, the mountains upon the east approach more closely to the railroad, which in its turn veers towards the lake as it progresses. In the northern part of Georgia, which is the summit on the Vermont and Canada Railroad, the tourist gets extended views of Lake Champlain, with its beautiful bays and islands. With so great a variety of scenery—the Adirondack Mountains in the west, the broad silvery lake in the distance between these gray mountains and the spectator, with the succession of meadow and forest, and hill and dell which intervene—the tourist can hardly fail to be delighted, especially during the autumnal season of the year.

Passing rapidly along, by the base of "Johnny-Cake Hill," so called, the long and shrill whistle from the engine is a premonitory symptom that the tourist is approaching St. Albans. This township, as well as Georgia and Swanton (which are adjacent to it), presents a fine field for the geological student, as already stated in other parts of this Report.

The intelligent tourist, in passing "Johnny Cake Hill," will not be surprised to learn that near its base are found specimens of slate which, in the opinion of the Hon. Augustus Young—late State Naturalist of Vermont—were, probably, well worthy of being wrought.

In a reconnoissance made in 1859, at St. Albans and vicinity, by Sir William E. Logan, F. R. S., Director of the Geological Survey of Canada, he found traces of copper on the east side of Johnny Cake Hill; and the rocks were found to be similar in appearance to those in Canada, which have already been economically wrought.

The village of St. Albans is situated nearly three miles from Lake Champlain; is admirably located on a high and fertile plateau, about four hundred feet above the lake; and for the thrift, economy, energy, and good taste of its citizens, is one of the most prominent villages in Vermont. Its commodious and, in some instances, elegant dwelling-houses and surrounding gardens; its solid blocks of business structures; its public buildings, and especially its new stone and brick churches, with massive towers and lofty spire; its spacious and attractive academy, or union school-house, with modern improvements; its large manufacturing establishments, comprising, with others of lesser note and magnitude, a car factory and an extensive iron foundery; its broad and well-

graded streets and shaded side-walks—all indicate to the eye of the tourist a preponderance of comfort and thrift, and a large and profitable amount of manufacturing and commercial business for which this village has become somewhat remarkable since the completion of the Vermont and Canada Railroad.

Among other points of interest, which the traveler will notice at St. Albans, is a large freight-house nearly four hundred feet long, calculated for the reception of an immense amount of produce and merchandize. A visit to this depot on market-days will convince any one that this large building is none too spacious for the accommodation of the business of Franklin County, of which St. Albans is the natural center as well as the County seat. A carefully prepared table of shipments of butter and cheese from the St. Albans Station, for the ten years next after the Vermont and Canada Railroad went into operation, is here submitted as an exponent of the wonderfully productive qualities of the County of Franklin, which ranks as *one* of the best agricultural counties if not *the best* in Vermont.

Amount of butter and cheese shipped from St. Albans Station (Vermont and Canada Railroad), from January 1, 1851, to December 31, 1860 (ten years), as taken from the books of the Company, and showing its value in dollars and cents:

Date.	*Pounds of Butter.*	*Pounds of Cheese.*
1851,	1,192,967	550,258
1852,	1,149,235	601,969
1853,	1,939,354	1,122,703
1854,	1,712,404	1,035,376
1855,	1,715,127	966,289
1856,	2,293,568	1,228,128
1857,	2,364,745	825,162
1858,	2,713,309	1,294,393
1859,	2,424,969	1,247,288
1860,	2,566,700	1,984,000
	20,072,378	10,855,566
		20,072,378
	Total butter and cheese,	30,927,944

20,072,378 lbs. of butter, at an average of 18c per lb., would amount to	$3,613,028.04
10,855,566 lbs. of cheese, at an average of 9c per lb., would amount to	977,000.94
	$4,590,028.98

It will be noticed that this official table indicates simply the shipment to market, from the St. Albans station, of two articles for ten years; while the amount of horses, cattle, pork, potatoes, wool, oats, and manufactured articles—such as mowing machines, railroad castings, and leather, if prepared and presented in a tabular form, would indicate the remarkably high degree of productive and manufacturing prosperity which Franklin County enjoys.

The traveler, while at Northfield, visited the grave of Charles Paine, who originated and was chiefly instrumental in building the Vermont Central Railroad. At Burlington, he stood beside the graves of Timothy Follett, with whose name the Rutland and Burlington Railroad will ever be associated, and of the Rev. Zadock Thompson, to whom the State of Vermont is largely indebted for an unselfish and industrious life spent in writing and illustrating her civil and natural history, as well as preparing the way for the success of the Geological Survey of the State. Here, at St. Albans, lies buried another State Naturalist, the Hon. AUGUSTUS YOUNG, who was born in Arlington, Vt., March 20, 1785, and died at St. Albans, June 17, 1857, having succeeded Prof. ZADOCK THOMPSON as State Naturalist by the appointment of the Hon. STEPHEN ROYCE, then Governor of Vermont; and here lies buried the Hon. JOHN SMITH, the originator, and for many years the President of the Vermont and Canada Railroad Company. To him and his colleagues, the late Gov. PAINE, Hon. LAWRENCE BRAINERD, of St. Albans, and JOSEPH CLARK, Esq., of Milton, will the State of Vermont always be indebted for the active employment of their time, money and influence for a series of years, while achieving the completion of a connecting link between the Northern (New York) Railroad on the west, and the Vermont Central on the east. To Mr. Smith's forecast and sagacity is the county of Franklin greatly indebted for the stimulus which has, during the last ten years, been given to the development of her agricultural and manufacturing resources. A beautiful memorial-stone of white marble, in the St. Albans Cemetery, indicates the spot where the mortal remains of this public benefactor repose, upon which is inscribed the following epitaph:

IN MEMORY OF

JOHN SMITH

BORN AT BARRE, MASS., AUG. 12, 1789.

DIED AT ST. ALBANS, VT., NOV. 20, 1858.

His private virtues, and the graces of a well ordered Christian life, endeared him to his family and friends, and qualified him for the distinguished position which he occupied at the Bar, and for the many offices of public and political trust which were bestowed upon him.

Taking a hasty look at the marble monuments which have been erected at St. Albans to the Hon. BENJAMIN SWIFT, late United States Senator; to Judges ASA ALDIS and BATES TURNER, of the Supreme Court of Vermont; to Lieut. CAMPBELL, U.S.A., and Purser GEORGE F. SAWYER, U.S.N., and to that gifted poetess Mrs. CHARLOTTE EMILY FAY, daughter of Rt. Rev. Bishop Hopkins and beloved wife of the Rev. Charles Fay, D.D., the tourist will bid a reluctant adieu to the attractive spot where so many men and women of mark lie buried, and resume his travel on the Vermont and Canada Railroad, from which he has been diverted by many points of interest in and about St. Albans.

The scenery, for which this section of Vermont has become greatly noted, will detain the tourist, however, a little while longer. The views of the lake and islands, mountains and forest, brooks and valleys which gladden the eye of the tourist as he looks to the west from Bellevue Mountain and "Aldis Hill" which lie near to, and directly east of, the village of St. Albans, beggar all description. The skillful pencils of Messrs. EDWARD W. NICHOLS of New York City, and C. L. HEYDE of Burlington, Vt., noted artists and landscape painters, have never been better employed than while occupied in making "counterfeit presentments" of the attractive landscape which is spread before the tourist from those elevated points.

At St. Albans are located the chief offices of the Vermont and Canada, Vermont Central and Sullivan Railroads; and here the managers of those corporations reside. The recent completion of a large and commodious station-house — with convenient business offices for the trustees, superintendent and other chief officials—and the liberal improvements which are in process of development for the more economical and thorough dispatch of business, indicate clearly that St. Albans must be henceforth one of the most important stations on the great railroad thoroughfare extending from the St. Lawrence to the Atlantic.

Leaving the St. Albans station, where possibly the tourist has been detained too long, he is favorably impressed with the character of the country through which the steam horse draws him. Midway between St. Albans and Swanton, he sees abundant specimens of the sandstone which pleased him at Mallett's Bay, and the same variety of marble which abounds in Colchester. He sees, also, from the cars, an inexhaustible quantity of limestone, from which an excellent quality of quicklime is manufactured in large quantities, and sent to all parts of the United States and Canada, by CHARLES W. RICH, Esq., and E. A. SMITH & Co. Their limekilns are in immediate proximity to the railroad, and their business of manufacturing and shipping quicklime seems to increase with each succeeding year. The high bluffs on the east of the track contain almost inexhaustible beds of Winooski marble; and on the west of the railroad are those extensive beds of pure carbonate of lime which are largely and profitably wrought by their enterprising proprietors.

The tourist will discover from the cars, in this vicinity, slate rocks from which valuable slate may hereafter be quarried, and whose economical uses may, in time, prove to be of great economical importance.

Passing the limekilns a short distance, the geological tourist will be interested in the material of which the road-bed is built. Near the dwelling-house of Mr. Charles Bullard is a small filling of the road-bed made from the material taken from a cut further north, through which the railroad passes. Upon a narrow examination this is found to be chiefly composed of *marine shells*, which have been collected here in sufficient quantity for the filling alluded to. The attention of travelers would be arrested by the white appearance of the sides of the cut. Few, however, would imagine that so great an accumulation of marine shells could be found at a point so far inland from the sea!

The winding course of the Missisquoi River is soon discovered by the tourist, at the east of the railroad, while Swanton and McQuam bays may be seen encroaching upon the level land at the west. The Swanton station is reached after traveling nearly ten miles from St. Albans. The village of Swanton, possessing a valuable water power, an excellent grist-mill and marble and other factories, has capacity for being made a thriving manufacturing village. The tourist sees, on an elevation east of the River Missisquoi, a small but attractive village, with its churches, academy, and other public buildings, through the intervening shrubbery and trees. Visitors intending to visit "Highgate Springs," for health or pleasure, must leave the cars at Swanton and travel nearly four miles before reaching the noted medicinal spring, which has been partially noticed in previous pages of this Report.

The analysis of the mineral waters of Highgate Springs, which has been ably and thoroughly made by Dr. THOMAS STERRY HUNT, the learned and experienced Chemist and Mineralogist to the Provincial Geological Survey of Canada, is here given in detail, as courteously and generously furnished for the purpose by Dr. Hunt:

The waters of Highgate Springs contain, in 1000 parts, as follows:

Chlorid of sodium,	.402
Sulphate of soda,	.042
Carbonate of soda,	.235
Carbonate of lime,	.024
Carbonate of magnesia,	.010
Potash and boracic acid not determined,	....
	.713

A careful geological examination of the rocks and fossils of Swanton and Highgate Springs, by Rev. John B. Perry and Dr. George M. Hall, of Swanton, has been followed by an important discovery of some new or little known species of lower Silurian fossils from the Potsdam group, which have recently been described and illustrated by E. BILLINGS, Esq., F. G. S., the Palæontologist of the Canada Geological Survey. Some of these fossils have been named after the discoverers.

In passing northerly from Swanton Falls, a few miles through a marsh and across Charcoal Creek to Hog Island, the tourist enters upon a section of country unlike that of any other part of Vermont. It is low, level, and swampy. If the traveler be familiar with the tradition that "Hog Island" and its environs, in the early settlement of the country, was visited by an earthquake* and thereupon settled down several feet below the primitive level and let water flow in upon it, he will readily be inclined to give credence to the story. Trees of large growth, and not generally found in wet places, are found here, and in high water have their roots and the lower part of their trunks under water!

It is not important or convenient to discuss the cause of this phenomenon, or to weigh the testimony in support of the alleged fact that the shock of an earthquake has been experienced in this locality. Suffice it to rest assured of the fact, that "Hog Island" is now lower than when those large trees first took root, but not so low as to form a beach in that part of Swanton before referred to, where such deposits of marine shells were discovered.

If the lands at Swanton and along the shores of Lake Champlain have been elevated (for marine shells are of common occurrence nearly the entire length of the lake), it is safe to conclude that it does not occupy a fixed position, and portions of it may be subsiding, while other parts are becoming more elevated.

Be this as it may, the traveler will find that the railroad safely passes over this anomalous sinking island, and soon touches the end of a bridge, almost a mile in length, near the entrance to Missisquoi Bay, which is one of the largest and most beautiful bays of Lake Champlain. The bridge was built by HENRY R. CAMPBELL, Esq., on piles and piers, with a peculiarly constructed draw-bridge, for the passage of vessels bound to Canada, at an expense of over eighty thousand dollars, and will invite the inspection of the scientific mechanic, and challenge his admiration. At the west end of this bridge the traveler reaches the Alburgh Springs station, which is sixteen miles from St. Albans and eight miles from Rouse's Point.

* See the Natural and Political History of the State of Vermont, by Gen. Ira Allen; 8vo., London, 1798; pp. 14, 15.

A drive of a few minutes, by horse power, over a good road, brings the tourist to the famous medicinal springs, known as Alburgh Springs. Pains having been taken to procure a scientific analysis of the water of Alburgh Springs, which is here presented as made by Dr. Thomas Sterry Hunt, who has analyzed the waters of Highgate Springs, as given in detail in a previous page of this Report. The analysis has been made with great nicety, by the experienced chemist who had the analysis in charge, and may be relied upon as correct in every particular:

The waters contain, in 1000 parts, as follows:

Chlorid of sodium,	.140
Sulphate of soda,	.024
Carbonate of soda,	.230
Carbonate of lime,	.036
Carbonate of magnesia,	.022
Potash and boracic acid not determined,	...
	.452

"These two mineral waters," says Dr. Hunt "issue from the rocks of the Hudson group, and resemble closely those from the same rocks in Canada, such as the springs of Chambly and St. Gregoire. They are characterized by the presence of considerable portions of bicarbonate of soda, besides chloride of sodium and a little sulphate of soda, with bicarbonates of lime and magnesia. Both of the waters yield strong indications of boracic acid, and contain small portions of potash salts. They are, besides, impregnated with sulphureted hydrogen, the quantity of which could not be determined with accuracy in the sample sent me for analysis. In the results, the amount of carbonate of soda was calculated from the excess of the soda salts over the amount required by the chlorine and sulphuric acid, and with the lime and magnesia is represented as a simple carbonate, though all these are, probably, present in the waters as bicarbonates. The potash and boracic acid were not determined."

Traveling along rapidly from Alburgh Springs station, the station of Alburgh and West Alburgh are soon reached. This point and the one opposite, Rouse's Point, are of great interest to the traveler, on account of the remarkable railway connection, which, by the exercise of extraordinary enterprise, mechanical ingenuity, and perseverance, has been here effected between the Vermont and Canada and the Ogdensburgh railroads, and by which not only those two important lines, but the two States of Vermont and New York — before accessible to each other for a hundred miles along their borders only by water craft — have become connected by an unbroken line of rails extending over bridge and bridge-boat, a mile across the lake.

"This bridge, in its whole length, is five thousand two hundred and ninety feet, or one mile and two rods, and was erected at a total cost of sixty thousand dollars, of which about twenty thousand dollars were expended on the draw, or, as it is usually and perhaps more properly called, the *Boat-Bridge*. Three-fifths of the whole structure, including the Boat-Bridge, were built by the Vermont and Canada, and Vermont Central, and the remaining two-fifths by the Ogdensburgh Railroad. The Boat-Bridge, or that part which swings open to permit the passage of vessels, and is thus made to serve the purposes of a huge draw, is of the great length of three hundred and one feet, and is an entirely independent structure—in fact, a regular boat, with iron rails running over its deck, and so brought to the level and line of the adjoining bridge and track, at the ends, by substantial and secure fastenings, that the whole is brought into a perfect junction, and made to form a continuous line of rails from one side of the lake to the other. In a side hold of this boat was placed a small steam engine, which, by winding up on a drum a strong iron chain passing to one end of the boat, and thence to a pier, will, in the space of one minute, throw out the boat at right angles, and, in another, after the vessel has passed through, by reversing the revolutions of the drum, bring it back to its place.

"This novel contrivance, the only one of the kind ever invented, or at least the only one ever put in operation, it is believed was, at first, the offspring of a necessity. The legislatures of Vermont and New York, jealous of the rights of the people navigating the lake, refused, at that time, to grant the privilege of bridging the lake, except on the condition that three hundred feet in width of the channel be left open, or be made to be opened, for the passage of vessels. No draw-bridge could be constructed to open to such an extent; and hence arose the great desideratum of some contrivance to insure a continuous line of rails across the lake, so as to obviate the damaging necessity of breaking up the trains on the lake shores, and resorting to ferry-boats for the transit of passengers and freight. And that desideratum was, after some experimenting, at length fully realized in the construction of the present Boat-Bridge, which has now been for about ten years in successful operation, having, during the whole time, led to no accident and no important detention of the trains. This invention—for such it truly was—mainly originated in the active brain of HENRY R. CAMPBELL, Esq., the noted master bridge builder of the Vermont Central and Vermont and Canada line of railroads, who—acting on the suggestion of the late GOVERNOR PAINE, of the possibility of constructing some floating craft into which the cars could be run, and then passed over the unbridged part of the lake—went to work, perfected, and put in operation the remarkable contrivance which has so often elicited the surprise and admiration of the visiting tourist. And few who carefully inspect its simple but efficient machinery, and witness the facility and exactness of its working, will fail to pronounce it an achievement which does honor to the projector.

"Many interesting features of the handsome landscape open to the eye of the observer at this place. The bright expanse of the widening lake on the left, the long, low-lying islands, and the variegated shores of New York, stretch away southward and gradually swell up into the distant highlands. Fort Montgomery, a great work of national defence, boldly jutting out into the lake from the New York shore, some two hundred rods north of the bridge, not only presents to the eye, in the rugged grandeur of its high and immense walls of solid stone masonry, a very imposing spectacle, but brings to the mind those associated events of our history which are alike interesting and instructive themes for our contemplation. The ancient history of this fort, with all well posted in our early history, will be readily recalled; but its modern history, probably, is familiar to a much fewer number. The site of the old Fort Montgomery was twenty or thirty rods south of that of the present one, and on and around a low, stony point, which was the original ROUSE'S POINT—a name taken from an early settler of the adjoining lands. But when our general government provided for rebuilding the fort, it was decided to change the location the distance above named to the north, where, nearly a furlong further out into the lake, the foundations of the present immense superstructure were laid, and the intermediate shallows, except space for a moat, raised from the water by extensive fills of earth. These works, after having progressed awhile, at length attracted the attention of the British authorities, who notified our government that we were building within the limits of their territory. Little was done about it, however, till the boundary line was run under the Ashburton and Webster treaty, when it was found that the fort was indeed located considerably north of the 45th parallel of latitude, the old treaty line, and was, therefore, clearly within British limits. But as Ashburton was anxious that we should make a considerable concession in regard to a portion of the old line in Maine, he at length consented to make one in our favor here, and so vary the boundary as to bring these works within the United States. And, accordingly, a boundary monument was placed, where it is still to be found, a short distance in shore, just far enough north to make the line clear the works, with one of its faces inscribed, BOUNDARY LINE, &c., 45° 00′ 42″.

"These works, which cover three or four acres of ground, are still unfinished, but will, when completed, make a fortress of so formidable a character, that, under its scores of heavy guns, ranging for miles each way up and down the lake, as well as across it, no ordinary fleet could pass without absolute destruction."

We have availed ourselves of the description thus given of this locality, by the Hon. Daniel P. Thompson, of Montpelier, as being, in all respects, reliable and admirably graphic. Rouse's Point is the western terminus of the Vermont and Canada Railroad, whose entire length of fifty-seven miles the traveler has not, we trust, traversed without pleasure and profit. A level country extends far to the north from this point, and, instead of the bold and picturesque scenery so lately seen while passing near the western base of the Green Mountains, there is a broad expanse of level country spread out, and the traveler need not be apprised that he has left the Green Mountain State, and entered the north-eastern corner of New York, with the broad valley of the St. Lawrence in full view to the north.

We ought not to close this notice of the Vermont and Canada Railroad without an expression of thanks to its managers, and especially to the Hon. John Gregory Smith and G. Merrill, Esq., of St. Albans, for many acts of kindness and liberality which they have bestowed upon us during our onerous labors upon the Geological Survey, and for which our gratitude is due, and our thanks are thus publicly returned.

THE RUTLAND AND BURLINGTON RAILROAD.

This road was incorporated November 1, 1843, by the name of the Champlain and Connecticut River Railroad Company. November 6, 1847, the corporate name was changed to Rutland and Burlington Railroad Company. It was chartered for the purpose of constructing a "railroad from some point at Burlington, thence southwardly through the counties of Addison, Rutland and Windsor or Windham, to some point on the west bank of the Connecticut River." It extends from Bellows Falls to Burlington, a distance of 119½ miles, and passes through portions of the valleys of Williams and Black Rivers upon the eastern side of the Green Mountains, and along the valley of Otter Creek and Lake Champlain upon the western side.

At Bellows Falls, the tourist will be pleased at the loveliness of the varied scenes around him. Upon one side terrace upon terrace is seen to rise, and their smoothly rounded sides appear as though art had been employed to give them symmetry of form, while upon the opposite side of the Connecticut may be seen the rugged sides of Kilburn Peak, half hidden by the scattering pines — dwarfed representatives of their majestic progenitors, that once were so abundant in the valley of the Connecticut. The river here adds much to the beauty of the scenery. To the north, it may be seen spreading out like a lake with verdant headlands skirting it, but upon its approach to the village it is contracted by rocky barriers so that it is only about twenty rods in width. At this place it makes a fearful plunge over a ledge of gneiss that rises so high, near the center of the stream, as to cut the current and cause it to pass through channels on either side, and rush into the deep gorge below. Again, and yet again, the current leaps down the sloping ledges, between the rocky walls that rise on either side, till soon it reaches a whirling eddy more than forty feet below the upper brink from which it lately started.— Three bridges span the rocky gorge through which these waters rush, and being nicely finished works of art, add beauty to the scenery by their contrast with the wild and picturesque surroundings.

Leaving the village of Bellows Falls, the railroad passes upon the western bank of the Connecticut to the mouth of Williams River, when it veers to the north-west up the south bank of that stream with nothing to interest the tourist till Brockway's Mills are reached, when a deep gorge opens in which may be seen the eddying waters just below a picturesque water-fall near which the mills are erected. A good farming country now opens, and good farms abound on the line through Rockingham and Chester.

About one mile north of Chester depot, the road passes through a swamp which we conclude must have been a pond — not a large one — but which has become filled, or covered over with vegetable matter. We are led to this conclusion from the fact that when the railroad was being built, the workmen, after having made quite a heavy fill of gravel from an adjacent terrace upon the muck of the swamp, were surprised one morning after a heavy shower in the night to discover that the road upon which they had been at work had sunk several feet, and was out of sight! Many additions of gravel were made to this portion of the road before it was sufficiently high and permanent for cars to pass over.

We can furnish no other solution to this interesting problem than the one submitted, inferring that the crust of vegetable matter which had accumulated upon the pond was adequate to sustain the growth of trees and shrubs in the swamp, but insufficient to support the gravel placed there in the construction of the railroad.

Hastening up the valley of Williams River and crossing the stream several times, the tourist leaves it soon after passing Gassett's Station and darts into another valley through which Black River doubtless ran during the early ages of the earth's history.

Soon after entering Cavendish a deep gorge between Hawk's Mountain and Dutton's Hill is entered, in which abundant evidence is presented in the water-worn appearance of the rocks and in the numerous "pot holes," that a large stream of water once had its

course through this gulf. Sections of pot-holes, fifteen and twenty feet in diameter, and those of smaller dimensions, are upon the sides of the railroad and in full view from the cars. A small brook, sustained by the water from a few springs, winds along through the gorge, a diminutive representative of the powerful current that cut down this deep abyss, and left in it such fantastic markings.

Emerging from the north end of Duttonsville Gulf, Cavendish village breaks in upon the view, and Black River is seen, eighty feet below the railroad, running through the fertile valley and suddenly disappearing in a deep, dark gorge, the rocky walls of which are more precipitous than those in the gulf just passed.

The numerous terraces that skirt the valleys, and the high rocky walls that rise on either side of the deep gorge through which the river now escapes, give evidence that before that rocky barrier was cut asunder by the stream a lake or pond existed in the valley, the outlet of which lay through Duttonsville Gulf.

The lover of the picturesque and sublime in nature would do well to stop at Proctorsville or Cavendish, which are near at hand, and visit

CAVENDISH FALLS.

As Black River is about entering the deep gorge one half mile south of the village of Cavendish, yankee enterprise has arrested it in its course by springing a dam across the stream, and upon the ragged rocks of the southern bank are placed a saw mill and chair factory.

But the waters, leaping over the dam, go dancing down through the deep ravine as though rejoicing in their liberty, and exulting at the great victory they had won in the remote past over the adjacent rocks by cutting that yawning and cavernous gorge through them. Here is one of the most interesting cases of erosion ever recorded by the hand of time, not even excepting the far-famed gorge below Niagara Falls.

The prediction that the chain of lakes above Niagara will ultimately—but at some far distant day—be drained through the deep worn channel that will extend to them, is in this case verified. The chain of lakes that once existed in the terraced basins of Black River valley — where now are located the pleasant and thriving villages of Cavendish, Proctorsville and Ludlow — had an outlet, as we have seen, through Duttonsville Gulf. A high rocky barrier extended along the eastern end, through which the stream finally found a passage at a lower level, by which the lakes were ultimately drained, and pleasant village sites afforded.

Passing down upon the south-western side of the stream the geologist will observe a large and extensive bed of dolomitic limestone, with gneiss lying beneath, and mica schist above it. Standing upon this bed, which has a western dip of 40°, and looking to the south, he will find that it runs in line with Duttonsville Gulf—and at once there is suggested a theory to account for the occurrence of this gorge. The crumbling nature of the limestone, superinduced by its rapid disintegration and decomposition, would with the active agency of water result in the formation of a valley along its line of deposit.— Upon examination, beds of limestone are found not only in the Gulf but at its extreme southern end.

Without pursuing this train of thought further, we will notice an incident that occurred at this place: Some years since, as Varnum Lockwood was digging limestone from this ledge, near the southern brink of the river, by springing hard upon his iron bar he lost his balance and was thrown over the precipice into the whirling eddy, fifty-six feet below. His companions, rushing to the brink, beheld him buffeting with the high swelling waves, which ever and anon would engulf him, in spite of his frantic efforts to escape. At last he succeeded in securing a hold upon a jutting rock, by which he drew himself from the water in an almost exhausted state. He was beyond the reach of his companions, who, solicitous for his welfare, but unable to descend into the deep abyss to help him, made earnest inquiries whether he was much injured by the fall. Looking up, and intently feeling in his pockets, while the water ran in torrents from his drenched person, he replied: "The fall didn't hurt me, but I'm darned 'fraid I've lost my jack-knife." From this circumstance the place is called Varnum's Point.

Passing down the southern bank a distance of forty rods, the "Lover's Leap" is reached. Tradition does not inform us of any suicidal act committed here by lovers, but some one, to designate to visitors the name of this and other spots of interest, has painted upon the rocks this name.

Here the jutting mica schist stands out in an angle of the stream, affording one who has the nerve to stand upon a perpendicular precipice, a hundred feet above the foaming current that lashes itself in the deep abyss below him, one of the wildest and most romantic scenes in nature. To the west is seen, amid the giant bowlders, the rushing waters flowing on apace, as though in haste to reach the base of "Lover's Leap;" then, turning abruptly at right angles down the stream, they speed their way directly to the north, and often hide their foamy caps beneath the gigantic bowlders that are thrown together in stupendous heaps, and, in low water, bridge the deep-worn channel.

A few steps further east, and "Prospect Point" is reached. Here is not only shown the picturesque surroundings seen from Lover's Leap, but the *modus operandi* by which the gorge was made is also here suggested. A deep and long-extended crack across the strata is visible at this point, and, if we conjecture right, through this the water first escaped from out the chain of lakes before alluded to.

Like the first unwise step taken from the path of rectitude in a life of crime, so this fissure—which at first afforded a passage for only a limited amount of water, which percolated slowly through it—in time grew so wide as to furnish little restraint to the onward course of the current. From a place difficult of access, just below Prospect Point, a photographic view of the gorge to the west, with Lover's Leap at the left hand, was taken by Mr. Styles, of Burlington, from which Plate XXV. was obtained.

Passing down some fifty rods on a rustic foot-path skirted with thick underbrush of evergreen and forest trees, the visitor finds himself near the entrance to the cave in the "Rotunda." This, as its name implies, is a circular inclosure surrounded with a smoothly worn and water-washed ledge, the top and sides of which are arrayed in that drapery which nature uses to decorate her wildest and most secluded haunts. Tuckerman with all his successful labors in collecting lichens and mosses, can exhibit no rarer or more beautiful varieties than are used to deck the rocks of this romantic spot. "Eureka Cave," just round a jutting point of rock next claims a visit. No pendant stalactites are found upon the roof of this spacious cavern, for the roof is mica schist and solid; but the smooth rounded outline of its walls proclaims the fact that water was the agent employed to scoop out this deep recess.

Less than half a dozen rods from the cave, upon the verge of the stream, the pre-Adamic waters scooped out a pot-hole that now is elevated about twenty feet above the river-bed, and of a size sufficient to admit a dozen persons. Leaning over the western edge of this rock-basin, one of the wildest and most beautiful views is opened to the spectator.

As far up and down the stream as the eye can reach are seen gigantic bowlders piled together in great profusion, with high and overhanging rocks on either side, in which are deep indented niches and fantastic carvings made by water, which bring to the mind of the beholder the descriptions he has had of ruined amphitheaters and the old city Petra, cut by man out of the solid rock.

Years were required to perfect and bring to ruin those works of art,—but untold centuries rolled round, while water was at work in this sequestered glen in giving the final touch to this master-work of nature.

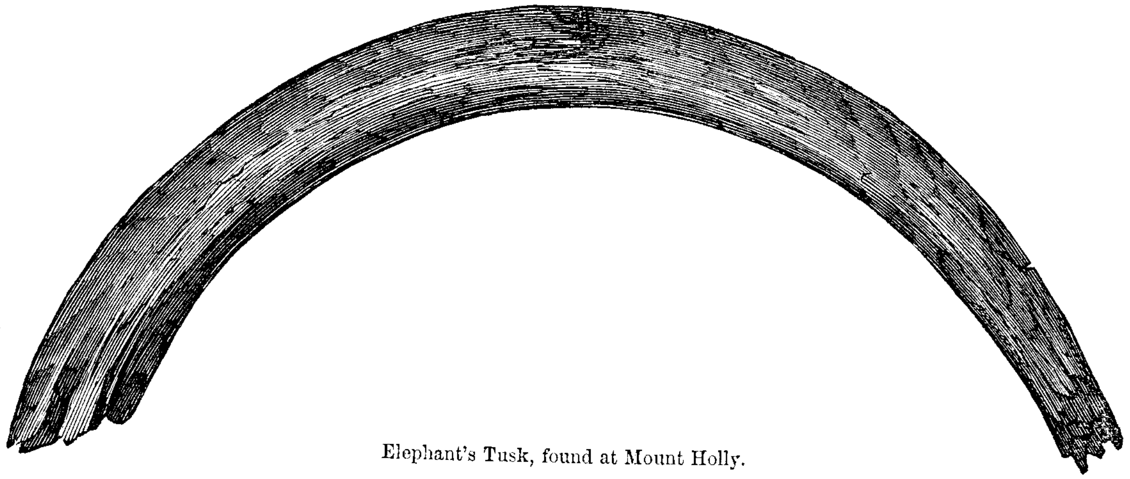
Still further down the stream towards Whitesville, which is about one mile distant from these falls, are other points of interest, among which is "Alcove Point." Here, by some curious freaks of water, the rocks upon the western bank for many rods in length are worn so as to present a succession of pot-hole sections or alcoves, which circumstance gave rise to the name.

Niagara can be painted, and withal makes a good picture; but that picture never awakens the enthusiasm that one feels in beholding the reality, and so it is with Cavendish Falls and their surroundings. The photographs obtained of the falls by Miller and Styles, and the engraving appended to this Report (Plate XXV.), may convey to the mind faint shadows of the reality, but the lover of the beautiful in nature, if he would feel the glow of inspiration afforded in contemplating the grandeur of these falls, must visit them in person, and from numerous points of observation, amid the roar of the rushing waters, take repeated observations.

Resuming our route upon the railroad, we are soon brought to Proctorsville—the point from which persons for Plymouth gold diggings leave the cars. The cars pass directly through this pleasant village, rendered interesting by the fine exhibition of terraces around it which furnish conclusive evidence that this ground too was once the bed of a lake—a continuation of the one in which Cavendish village is situated. Following up the valley of Black River, the hills of serpentine about one half mile west of Proctorsville rear their pinnacled summits in full view from the road, presenting a rough outline peculiar to outcrops of the Verd-antique marble.

Ludlow village is next reached, and, when seen from the railroad that winds in a graceful curve along the hill-side far above the tops of the dwellings, presents a pleasing view. Up, and still upward, the road passes till the summit is reached in Mount Holly. For the distance of 180 rods east of the summit there is a rock-cut from ten to forty feet deep in gneiss, through which the cars now run, which made heavy drafts upon the treasury of the original stockholders. Near the western terminus of this rock-cut, and within a few feet of the summit, is the spot where were exhumed a portion of the skeleton and the tusks of a fossil elephant. A muck-bed occurs at the summit, and in this were found the remains alluded to, where the workmen were excavating for the railroad during the year 1848 at the depth of eleven feet below the surface, and at an elevation of 1415 feet above tide water. Most of the bones found, including a molar tooth, were taken by the workmen and others and carried out of the State. But one of the tusks — the most perfect one — was secured by Prof. Zadock Thompson, and is now lodged in the State Cabinet at Montpelier. A view of this tusk, which has a length of eighty inches and a diameter of four inches, is given below.

Fig. 339.



Elephant's Tusk, found at Mount Holly.

A plaster cast of the molar tooth, which is now in the possession of Prof. Agassiz, and weighs eight pounds, is also upon exhibition in the Cabinet, and presents a grinding surface about eight inches long and four broad.

The swamp in which these fossils were found was of limited extent, and occupied a small rock-basin; and from the fact that in it billets of wood, which had been cut off by beavers, were quite numerous, the inference is conclusive that it was originally a pond of water.

The appearance of the country around the summit is not decidedly broken, but the traveler is conscious that he is upon elevated ground. He sees around him no high peaks, but moderate swells, covered with spruce and hemlock.

Bowlders of Green Mountain gneiss are abundant, and the soil has the appearance of sterility. Many a taunting remark, by persons passing along the road, has been applied to people who can live in such a sterile region as this; but the substantial and commodious farm-house and barns, that ever and anon are seen, give evidence of the industry and wealth of its inhabitants.

The tourist misjudges if he thinks Mount Holly a poor town; for few towns in Vermont furnish more cattle, sheep, butter and cheese for market, and a greater proportion of independent farmers, than Mount Holly.

Upon reaching East Wallingford station, Mill River valley is entered and the railroad passes down the stream through Wallingford and Shrewsbury. Before reaching Cuttingsville station, the tourist will observe far up the hill-side a long ridge of red material, which appears to have been thrown out from a deep ditch near by. This marks the spot

where copperas was manufactured many years since; and these huge piles are accumulations of what was left after the copperas was manufactured. The red color results from the oxydized ore that had been leached. Upon the opposite side of the valley, just beyond and above Cuttingsville, may be seen a granite mountain, the only one upon the line of the railroad upon the west side of the mountain.

Passing Cuttingsville, the road winds along the northern bank of Mill River about one mile, when the latter suddenly turns in its course and leaps into a deep gorge between perpendicular walls of talcose schist. High terraces abound in this vicinity, and there is presented abundant evidence that Mill River once ran through the v lley where the railroad is located. An interesting fact in connection with this gorge is, that in a line with it, upon the opposite side of the railroad, may be seen a deep fissure extending far up the hill-side, which furnishes proof that the channel of the stream was probably changed by reason of a rending of the strata, which in time was worn sufficiently wide to allow the whole current of the stream to pass through it.

Hastening along the down-grade of the road, the traveler discovers the rich farming lands of Clarendon, far beyond which, and apparently at the end of a wide valley, may be seen Danby Mountain. When the light is favorable, far up the steep sides may be discerned white spots, which mark the localities of several marble quarries. The Taconic Mountains are seen, and seem to form an impassable barrier to the west, and through a narrow gap may be seen the rough and pointed summit of Bird Mountain.

While admiring the solitary grandeur of the mountains, and witnessing the abundant evidence of fertility of the wide-spread intervals, the tourist is admonished, by the continuous whistle of the engine, that he is approaching, and not far from, Rutland station. Arriving at the spacious depot and stepping into the street, the traveler is impressed with the fact that the portion of the village visible from this point is comparatively new. Spacious public buildings, tasteful private residences, substantial and elegant blocks for stores, all built in modern style, give convincing proof of the rapid growth of the place, and the refined taste of its citizens. A place hallowed by the associations that cluster around the names of the Williamses, the Pierpoints, and the Hodges, must have peculiar attractions to such as are familiar with the civil history of our State. And equally interesting must Rutland be to the man of science or the admirer of the beautiful in nature.

Her valuable marble quarries, which have furnished memorial stones that have been taken to every State of the Union, and proved sources of wealth to the proprietors, should claim a visit from each sojourner. The delightful "drives," and the beautiful scenery everywhere visible in the town, combine to make this one of the interesting points which the tourist should not fail to visit.

Killington Peak, which may be seen in its solitary grandeur to the north-east from this village, is more accessible from this place than from any other point on the line of the railroad.

Without stopping longer, we will return to the depot, through which the Rutland and Burlington Railroad passes, and in which the Rutland and Washington and Western Vermont railroads terminate. Evidences of order and good management are apparent around the depot and in the several offices connected therewith. To the managers of the Rutland and Burlington Railroad, and especially to E. A. Chapin, Esq., the gentlemanly superintendent, we feel under many obligations for courtesies extended during the progress of the Geological Survey of the State.

Again upon the cars, the traveler is briskly taken from the thriving village of Rutland and soon arrives at Center Rutland, where are two large mills for sawing marble. The first reached is that of Messrs. W. Y. Ripley & Son, and seen to the left of the road near the northern bank of Otter Creek, which at this place has a fall sufficient to afford an excellent water-power, a portion of which has been secured for the purpose of sawing marble. A little further on and another fall occurs in the stream, near which the spacious marble mill of Messrs. Clement & Gilmore is seen.

At this place the railroad turns towards the north and passes down the fertile valley of Otter Creek. Sutherland Falls is the next station reached, at which place are the marble mills and quarry of the Sutherland Falls Marble Company, and exhibitions of some of the most delightful scenery found in Vermont. Through the kindness of A. L. Rawson, Esq., of Syracuse, New York, we were furnished a sketch of Sutherland Falls, from which Plate XXIII. was obtained. At these falls is afforded one of the most valuable mill privileges found in the State, and, as the sketch indicates, the surroundings are eminently picturesque and beautiful. The spot is well worthy a visit from one who justly appreciates beautiful scenery, but if the tourist insists upon pursuing his route upon the railroad, we will call his attention to the beautiful prospect presented as he emerges from the deep rock-cut through which he passes, a short distance north from the falls just passed.

A wide-spread and beautiful valley opens to the north and east, thickly studded with comfortable and oftentimes elegant farm-houses, with well-fenced and highly cultivated fields, beyond which to the north may be seen the cluster of buildings that form Pittsford village.

To the east may be seen the wild towering peaks of Pico, Killington and Shrewsbury, which may be readily recognized by any one familiar with Plate XXIV.

Passing through the excellent farming town of Pittsford, admiring the scenery upon the east that passes by like a moving panorama, the traveler is hurried along to Brandon. Arriving at this place he must not fail to visit the numerous objects of interest in and around this thriving village. The *frozen well* upon one side, and the numerous ore beds upon the other, with various manufactories in the village,—among the most noted of which may be reckoned the Iron Foundery and extensive works where the valuable platform scales of the Messrs. Howes are manufactured,—will claim the attention of the man of science and gratify the curiosity of the casual observer. By reference to the foregoing Report it will be seen that no town in the State furnishes a greater variety or more extensive deposits of valuable mineral wealth than Brandon.

At this place stages are in readiness to convey passengers to Lake Dunmore, which is so noted for its romantic loveliness, and situated north-east of Brandon, in Salisbury and Leicester. This is a beautiful expanse of water, limpid and pure as crystal, spread at the base of towering hills, which present a rough contour peculiar to hills composed of the unyielding quartz rock. At the east of the lake, upon the rough mountain side, a small stream rushes furiously down, forming innumerable cascades along its precipitous route. From A. F. Styles, Esq., an artist at Burlington, who has taken a great variety of photographs of Vermont scenery, we obtained a view of Lana Cascade, a name applied to one of the picturesque water-falls on the stream, from which Plate XXVI. was obtained.

By referring to the plate, amid the wild surroundings, a prominent figure may be seen in the foreground representing an irregular shaped rock, but which upon examining more closely reveals the profile of an old lady with pointed nose and chin, having a cowl upon her head and a large mantle extending from her shoulders.

A spacious hotel for the accommodation of summer visitors is built near the western margin of the lake.

Leaving Brandon the traveler is conducted to Whiting Station, near which are numerous limekilns that furnish large supplies of excellent quicklime. To the north of these is an extensive cedar swamp, which when properly reclaimed will furnish some of the most valuable land in the State. A level country is now seen,—and the Taconic Mountain range, which has been in full view to the west till Brandon station was reached, is now lost in the distance, and only slight elevations intervene between the railroad and Lake Champlain. Occasional glimpses of the Adirondack Mountains are seen in the hazy distance to the west, and upon the east the unbroken range of the Green Mountains is in full view—distant only a few miles.

Occasional spurs shoot off from the western base of the Green Mountains, and one such is seen from the cars soon after leaving Whiting Station, and is in full view till the cars have nearly reached Middlebury. At the south end of this spur or outlier, which is called Sunset Hill, the bold and mural escarpment on the south will be sure to arrest the attention of the tourist. It is near this southern point of the isolated mountain, and partly between it and the Green Mountain range, that Lake Dunmore is located. The geologist will not fail to notice, as he rides upon the cars, the numerous examples of drift striæ that are visible in spots where the earth has been removed from the rock to be used in the construction of the railroad.

As Middlebury is approached, there are seen upon a beautiful swell of land to the left several spacious buildings, which from their appearance are readily recognized as belonging to Middlebury College. It was at this place that Prof. Charles B. Adams, the first Geologist of the State, resided at the time of commencing the arduous labors of the Survey. Numerous other men, whose names are associated with the civil and literary history of the State, resided at Middlebury, among which might be named the Hon. Daniel Chipman, Ex-Governors Horace Eaton and William Slade, Hon. Horatio Seymour, LL.D., Hon. James Meacham, Hon. Peter Starr, LL. D., Hon. Samuel S. Phelps, and others.

The surroundings of Middlebury, as well as the village, are replete with interest. A fine water-fall on Otter Creek is visible from the central portions of the place, and less than two miles to the north is one of the most delightful rural retreats found in the State. Otter Creek has worn deep gorges through the limestone, and now makes fearful plunges over the rocky barriers that impede its course, which, with the picturesque surroundings, makes Belden's Falls well worth a visit from him who feels delight in contemplating a display of nature's wild and beautiful scenery.

The country around Middlebury is comparatively level, and the view from the top of the college buildings, or from Chipman's Hill—a round hillock north-east of the village—is quite extensive and pleasing.

Again upon the cars, the tourist notices several excavations from which marble has been obtained, but which at present are not worked. A hasty view is had of Belden's

Falls, which are upon the left, and soon the deep eroded valley of New Haven River is reached. In this is seen the village of Brooksville, near the junction of that stream with Otter Creek.

A level country now is entered, and were it not for the distant mountain peaks, the scenes around would much resemble those in a rich and highly cultivated prairie region of the west. Snake Mountain is seen to the west, and, upon reaching Vergennes the bold escarpment upon its western side, and the gradual slope upon the east, are clearly shown.

Vergennes is pleasantly situated upon a swell of land in full view from the cars. This being one of the oldest cities in New England, and the only one in Vermont, should claim a special visit. An excellent water-power is afforded at the falls upon Otter Creek, within the limits of this city. After having visited the United States Arsenal and other places of interest in the city, and taken a trip to Elgin Springs, only three miles distant, the tourist will resume his seat in the cars and pass on towards Burlington.

He will not proceed far, before his attention will be directed to the peculiar outline of the small uplifts to the north and east of him. In them he recognizes the same peculiar outline that characterizes Snake Mountain, and notices along the route the uniform dip of the rocks to the east at an angle nearly corresponding with the eastern slope of hills of the Red Sandrock range, amid which he is passing.

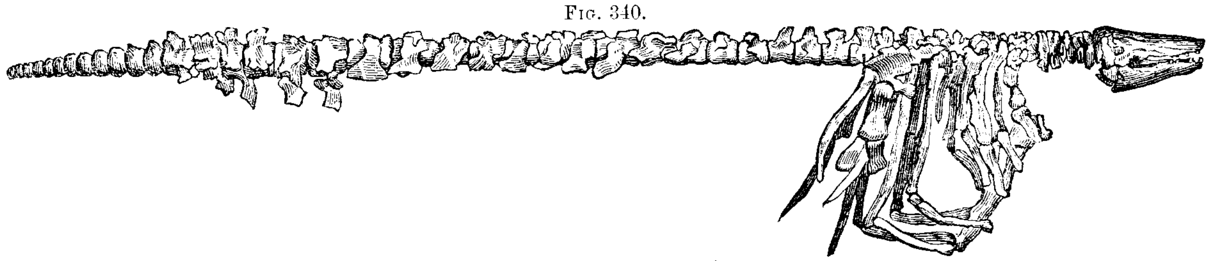
Marsh Hill and Shell House Mountain are seen in Ferrisburgh, and upon approaching Charlotte, the sharp-pointed peak Mount Philo or Sugar Loaf is seen, to the left of which Pease and Mutton Hills are recognized.

Before reaching Mount Philo, and even after passing it, the tourist will notice far to the east, when his vision is not obstructed by the intervening hills, a spine-shaped mountain, with its bleak, bare summit extending far above its fellows. This solitary sentinel of the Green Mountain range he at once recognizes as Camel's Hump.

In passing through Charlotte, the tourist should be reminded that about fifty rods north of the first road-crossing, in a cut a short distance—say twenty-five rods—south of the second crossing, is the spot from whence was exhumed the skeleton of a whale, in August, 1849. A full description of this skeleton, and the circumstances attending its discovery, are given at length in the scientific department of this Report, pp. 162—165.

Since that portion of the Report went to press, we have succeeded in securing a sketch of the whale, from which the following cut (Fig. 340) was obtained:

Fig. 340.



Fossil Whale (*Beluga Vermontana.*) [F. F. Currier Del.—J. Bruen Sc.]

It may be proper here to remark that the bones of the head were so much broken by the workmen who encountered it in making an excavation for the railroad, that but an imperfect idea of its shape could be obtained from the preserved fragments, by one not

familiar with comparative anatomy. The outline of the head, therefore, may not be true to nature; but the writer, acting in the capacity of Curator of the State Cabinet, concluded that an artificial head—embracing the bones that had been preserved—if attached to the skeleton, even if it were not a perfect model of the original, would be more attractive to the visitors at the State Cabinet than the remaining portion of the skeleton would be without a head; hence, he fitted it up, not to elicit the criticism of the learned zoologist, but to render the skeleton more interesting to the casual observer.

Without stopping longer to examine the skeleton, the intelligent tourist hastens on; but, when conscious that he is sixty feet above Lake Champlain, and one hundred and fifty feet above tide water, he at once directs his mind back through the remote past, to the time when this portion of the continent was sufficiently submerged to allow the waters of the ocean to extend over it, forming a broad inland gulf, with the Green Mountain range for its eastern shore, and the Adirondacks for its western limit.

The broad valley of the St. Lawrence would form the passage to this inland sea, or perchance only the higher portions of New England rose above the water; and what are now the Champlain and Hudson River valleys, were, in the days of this old Cetacean, a channel extending the entire length of the higher portions of New England.

While contemplating upon the changes that have been wrought by the subsidence and elevation of this portion of the earth's crust, and endeavoring to form an estimate of the time necessary for the accumulation of eight feet of sediment, which was found above the skeleton, and its subsequent elevation to its present height above the ocean, a bright expanse of water upon the left breaks in upon the view and awakens the tourist from his reverie.

Extended views of the lake are now visible from the cars, and soon Shelburne Bay is reached—a body of water not only beautiful to look upon, but one highly valued by fishermen. Soon after passing Shelburne Station, uplifts of red sandrock are numerous, and although dwarfed representations of the higher uplifts further south, of which Buck and Snake Mountains are types, they present to the eye a similar outline, and convey to the mind the reason why the red sandrock mountains possess their peculiar configuration.

Passing along with Lake Champlain in full view upon the west,—with the upturned edges of the red sandrock, and the rich suburban residences beyond, upon the east, the traveler is admonished that he is near Burlington, the terminus of the road upon which he is traveling.

Reviewing for a moment the route over which he has just passed, he is delighted with the recollection of the varied grandeur of the scenery amid which he has traveled, and wisely concludes that no railroad affords a better opportunity than the Rutland and Burlington for viewing the picturesque and bold mountain scenery, for which Vermont is so eminently distinguished.

Other railroads than those enumerated in the State, afford opportunities for witnessing beautiful exhibitions of scenery; but we have not had suitable opportunity for making a note of them, since we decided to adopt the plan of giving an account of the scenery in connection with the railroads. Well do we recollect, however,—when other business than that of noticing the surrounding scenery took us over the Rutland and Washington Railroad,—observing the beautifully diversified landscapes near the western borders of the State, rendered wild and picturesque by the occurrence of Haystack Mountain in Pawlet, and the more distant peaks known as Moose Horn Mountain in Wells, and Spruce Knob in Poultney.

The beautiful contrast afforded between the highly cultivated fields and smoothly rounded slate hills of Castleton, and the sharp-pointed and bleak summits of Bird and Herrick Mountains seen far to the east, was highly pleasing to the eye, and formed in their associated beauty a scene which will not soon be forgotten. The same too is true of the views which we witnessed upon the Western Vermont Railroad, in a trip from Rutland to Manchester. The smoothly worn ridges of the Green Mountains upon the east—in places the very type of sterility—contrasted finely with the rounded and more fertile Taconic hills upon the west.

The pass through the deep and narrow valley between Danby Mountain and the Green Mountain range presents a scene of wildness rarely witnessed, and contrasts beautifully with the rich and wide-spread valleys that open at its southern outlet, in which the thriving villages of Dorset, Factory Point and Manchester are located.

The railroad from Bellows Falls to Brattleboro, down the fertile and beautiful valley of the Connecticut, is surrounded by objects interesting to the traveler. Brattleboro village not only enjoys the advantages of a position amid the most delightful scenery, but the well-directed efforts of a community noted for its wealth, refinement and literary culture, have rendered the place one of the most attractive in the State. Elegant private residences are abundant in this village, some of which are owned by persons of wealth who do business in the city, and occupy these during the summer months. The highly cultivated taste and public spirit of the citizens are manifested in the tasteful public edifices and numerous improvements so often observed in that delightful village.

One of the many interesting views to be seen is from the common, westerly, up the fertile valley of Whetstone Brook. From a photograph taken by C. L. Howe, Esq., of Brattleboro, we obtained the sketch on Plate XXXV, in which is delineated, imperfectly, some of the interesting features that make up the picturesqueness of that lovely valley.

Gladly would we accompany our tourist longer, take him through the numerous thriving villages, over the highly cultivated farms, or into the more secluded portions of the State, and point out the rich array of interesting objects for contemplation, and let him find

> "———tongues in trees, books in the running brooks,
> Sermons in stones, and good in everything;"

but we are admonished that much time has already been taken in our attempts to portray a few of the many attractions that cluster around our native State, and therefore reluctantly refrain from pursuing further this difficult but interesting task.

Doubtless others will feel little of the enthusiasm, in the perusal of our imperfect delineations, which we enjoyed in the contemplation of the sublime realities; but, if the efforts which we have put forth shall arrest the attention of such as place a proper estimate upon the beautiful in nature, and awaken thought and direct the minds of Vermonters to a just appreciation of the numerous objects of interest so profusely distributed around them, or call forth additional descriptions from a more gifted pen than ours, by which the scenic

beauties of the State shall be faithfully depicted, we shall have attained to the gratification of our highest desire.

Before concluding this Report, however, we will take occasion to acknowledge the profound debt of gratitude under which we are placed, by the many manifestations of kindness extended to us in every portion of the State during the progress of our labors.

To give the names of all to whom we are thus indebted, would embrace nearly all those engaged in the pursuits of quarrying and mining, together with a very large proportion of the intelligent citizens of the State whom we have had the pleasure of meeting since the commencement of our work.

To the distinguished Principal of the Survey would we tender our grateful acknowledgments for the many favors shown, and especially for that token of confidence indicated in the commission constituting us one of his assistants.

Although the pecuniary emoluments have not been equal to what might have been realized from other pursuits, still, if the course pursued has been such as to render us deserving commendation for fidelity and perseverance we shall have accomplished our highest end and aim.

APPENDIX.

While this Report was passing through the press, we were informed that the Palæontologist of the Geological Survey of Canada, E. Billings, F. G. S., in company with, and assisted by Rev. J. B. Perry and Dr. G. M. Hall, of Swanton, had made explorations and valuable discoveries in the geological formations of Franklin County, Vermont. We wrote, asking Mr. Billings to furnish us with the result of their investigations, to which he kindly responded by sending us a pamphlet, giving a full and scientific description of the fossils collected, for which we tender our thanks, and gladly insert in this place.

The rocks in Canada, containing the fossils, being so closely allied to the formations in Northern Vermont, we have concluded to insert the descriptions in full, trusting that a more minute examination than any heretofore made will bring to light, in Vermont rocks, many if not all the fossils described by Mr. Billings.

We are also gratified in being able to announce that the Rev. J. B. Perry, of Swanton, has generously offered to furnish us with a suite of the fossils collected by him and Dr. Hall, that we may have them placed upon exhibition in the State Cabinet at Montpelier.

I. ON SOME NEW OR LITTLE KNOWN SPECIES OF LOWER SILURIAN FOSSILS FROM THE POTSDAM GROUP (PRIMORDIAL ZONE.)

BY E. BILLINGS, F. G. S.

The fossiliferous rocks on the north shore of the Straits of Belle Isle, from which a portion of the species hereinafter described were procured, consist of the following, in descending order:

1. Limestones. Reddish and greenish colored limestone, varying in some places to gray, with some red and green shale. The fossils are *Palæophycus incipiens*, *Archeocyathus Atlanticus*, *A. Minganensis*, *Obolus Labradoricus*, *Obolella chromatica*, *O. (?) cingulata*, *Paradoxides Vermontana*, *P. Thompsoni*, *Conocephalites miser*, *Bathyurus parvulus*, *B. senectus*, *Salterella rugosa*, *S. pulchella*, and *S. obtusa*. There are besides these, two species of *Orthis* and one of *Orthisina*, and numerous fragments of trilobites, apparently of several undescribed forms. The thickness of these limestones is one hundred and forty-one feet.

2. Sandstones. Gray, red, and reddish-gray sandstones, the lower beds holding pebbles of white quartz, from the size of a pea to one or two pounds in weight. The only fossil observed is *Scolithus linearis*. Thickness two hundred and thirty-one feet.

These rocks rest upon the Laurentian, and their fossils show them to be of the age of the Potsdam group. They were examined by Mr. J. Richardson during the past summer.

Another exposure of rocks of the same age occurs about three miles east of Phillipsburgh, in the County of Missisquoi, and extends south into the State of Vermont, where it is largely developed, and constitutes the red sandrock of the geologists of that State. During several visits made to this exposure last summer, I could find no fossils on the Canadian side of the boundary line, but several important localities occur in the immediate neighborhood in Vermont. At one of these, one and one-half miles east of Swanton, a number of species have been found by the Rev. J. B. Perry and Dr. G. M. Hall, of that town. These gentlemen are engaged in making a careful geological examination of the rocks and fossils of their neighborhood, and have requested me to describe the new species collected by them. At this locality *Palæophycus incipiens*, *Obolella cingulata*, *Paradoxides Vermontana*, and *P. Thompsoni* occur in the black slates, conformably interstratified with the sandstones and magnesian limestones, which constitute the principal mass of the formation. It will be observed that several other species are also found here; but the prevailing forms are the four above mentioned; and, as they are the most abundant in the limestones of the Straits of Belle Isle, there can be little doubt that the two deposits, although eight hundred and sixty miles distant from each other, are of the same age. The occurrence of *Scolithus linearis*, and the general aspect of the fossils, also show that these rocks must be very nearly, if not exactly, in the same geological horizon with the Upper Primal sandstones and slates of Pennsylvania.

Only one out of all the species collected in the above mentioned localities, is known to range upward. This is *Archeocyathus Minganensis*, which, however, has not been found above the lower half of the calciferous formation.

PLANTÆ.

SCOLITHUS LINEARIS.* (Hall.)

Scolithus linearis (Hall.) Pal. N. Y., Vol. I, Pl. I, Figs. 1, *a*, *b*, *c*.

This species occurs at Anse au Loup, in the sandstone, but I have not detected it in the limestone of that locality. The form differs from the one which is so common in the Potsdam sandstone of Canada, in being larger and straighter. It is perfectly identical with that of the Upper Primal sandstone of Pennsylvania, and also with that of the Potsdam sandstone of Tennessee. (Formation III. of Prof. Safford.)

PALÆOPHYCUS INCIPIENS. (N. sp.)

Description. This species consists of elongated, straight, or slightly curved stems, from half an inch to three-fourths of an inch in width. The transverse section is irregularly oval, with two acute edges, but it is probable that this flattened form is due to compression. Although numerous specimens lying in the rock were examined, no indication of branching was observed. The specimens are usually from four to six inches in length, but some are more than one foot. They occur abundantly on the surface of certain strata,

* For description of this fossil, see p. 326 of this Report.—A. D. H.

and the specimens from Anse au Loup are perfectly identical with those which abound in the slates near Swanton, in Vermont, holding *Conocephalites*, *Paradoxides Thompsoni*, *P. Vermontana*, &c.

Locality and Formation. Anse au Loup, on the north shore of the Straits of Belle Isle, in sandstone of the Potsdam group. Also one and one-half miles east of Swanton, in the State of Vermont, in rocks of the same age.

Collectors. J. Richardson, Rev. J. B. Perry, and Dr. G. M. Hall.

PALÆOPHYCUS CONGREGATUS. (N. sp.)

Description. Stems cylindrical, from one to four lines in diameter, often crowded together in such abundance as to completely cover the surface of the rock. They lie across each other in every direction, and appear to be so interlaced that where very thick the same stem can seldom be traced for more than one inch in length. They are either straight or crooked, and sometimes present sudden slight enlargements of the diameter, giving them a somewhat nodulose aspect.

Locality and Formation. One mile south of the boundary line, on the road leading from Moor's Corners in St. Armand to Saxe's Mills in Highgate, Vermont. In the thin beds of the Potsdam group. Red sandrock formation of Vermont.

Collector. Rev. J. B. Perry, Dr. G. M. Hall, and E. Billings.

AMORPHOZOA OR ZOOPHYTA.

In the limestone at Anse au Loup there are numerous fossils which from their radiated structure have the aspect of true corals, and yet in polished sections seem to possess the poriferous organization of sponges. I shall therefore leave it an open question as to which of the two divisions they should be referred. There appear to be two closely allied genera, but for the present I shall place all the species in one.

ARCHEOCYATHUS. (N. gen.)

Generic characters. Turbinate, simple or aggregate; cup deep. The internal structure so far as it can be made out, consists of an inner wall constituting the inner surface of the cup, and an external wall or epitheca enveloping the whole. Between the two walls are numerous radiating septa, the interseptal spaces being filled with poriferous or cellular tissue. It is highly probable that the inner wall is permeated by pores communicating with the interseptal tissue.

In *A. Atlanticus* the radiated structure is not so well defined as it is in the others, but still it can be observed in the polished sections. In *A. Minganensis* the septa are well developed, and give to the fossil the aspect of a *Petraia* or *Zaphrentis*. It may be that these two species should be placed in different genera, but as there are numerous fragments of what appear to be intermediate forms, it would seem to be the better course to group them together in the first instance.

ARCHEOCYATHUS ATLANTICUS. (N. sp.)

FIG. 341.

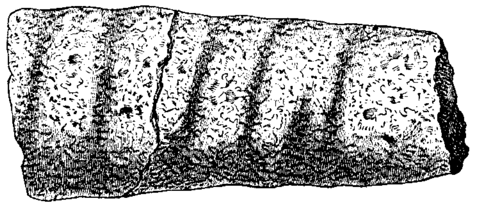


FIG. 342.

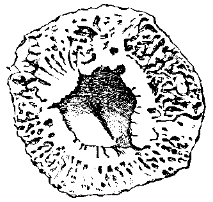


FIG. 343.

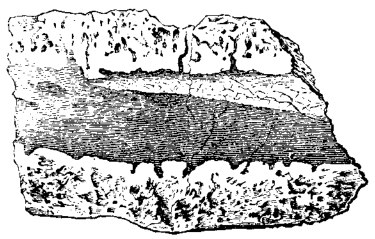


FIG. 344.

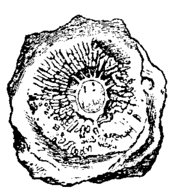


Fig. 341. A fragment of this species. Fig. 342. Transverse polished section of the same specimen. Fig. 343. Longitudinal section of the same. Fig. 344. The weathered extremity of a specimen with more numerous and regular septa, probably of a distinct species.

Description. The only specimen of this species in the collection is a fragment four inches and one-half in length, fourteen lines in diameter at the larger and nine lines at the smaller extremity. Where the diameter is eleven lines the cavity of the cup is four and one-half lines across, and the space between the walls three lines. Of the radiating poriferous septa there are about sixty; they are so irregular that it is only in certain places in finely polished sections that the radiated structure can be detected. On one side, where the specimen is weathered, the structure presents the appearance of a rather compact cellular tissue. The form appears to be elongate conical, gradually tapering, the surface marked by wide shallow encircling oblique annulations from three to six lines distant from each other. The outer wall does not seem to be poriferous, but this appearance may be due to the crystalline condition of the rock into which it is converted.

Locality and Formation. Anse au Loup on the north shore of the Straits of Belle Isle. In limestone of the Potsdam group.

Collector. J. Richardson.

ARCHEOCYATHUS MINGANENSIS. (Billings.)

Petraia Minganensis (Billings.) Canadian Naturalist and Geologist, Vol. IV, p. 346; 1859.

Description. Elongate, turbinate, rapidly expanding from the base for one or two inches, then becoming cylindrical. The form is that of a large *Cyathophyllum* or *Zaphrentis*. The cup extends in depth nearly to the base. The radiating septa are thin and closely crowded together, there being eight or ten in the width of three lines. The surface is annulated by strong, rough ridges, from one-fourth to half an inch apart, each ridge most abrupt on the upper side, and having an elevation of two or three lines above the bottom of the intervening furrows. The inner wall is exceedingly thin, apparently less than half a line. The base is curved for about two inches.

Specimens of the base attain a diameter of two inches in a length of three inches, but there is one fragment of the cylindrical part which must have belonged to an individual four inches in diameter. The large individuals appear to have attained a length of two feet or thereabouts.

The species was first described by me from casts of the interior of the cup, and placed provisionally in the genus *Petraia*. I think all the specimens collected at Anse au Loup and in the Calciferous sandrock at the Mingan Islands, belong to the same species.

Locality and Formation. Anse au Loup, on the north shore of the Straits of Belle Isle, in limestone of the Potsdam group. Also at Romain's Island, and on the north side of Harbor Island, in the lower half of the Calciferous formation.

Collector. J. Richardson.

BRACHIOPODA.

OBOLUS LABRADORICUS. (N. sp.)

Description. Dorsal valve subcircular, the hinge-line straight and equal to about three-fourths the width of the shell; rather strongly and uniformly convex, most prominent at one-fourth the length from the beak, the latter small, neatly pointed, scarcely distinct from the cardinal edge. Surface with fine concentric striæ, which converge slightly on approaching the cardinal edge, fifteen to twenty in one line, and also with a few coarser concentric undulations of growth, the whole crossed by minute radiating striæ just visible to the naked eye. The shell is black and friable like that of a *Lingula*. Length, five and one-half lines; width, about six lines.

Fig. 345.

Dorsal valve of O. Labradoricus.

Ventral valve unknown.

Locality and Formation. Anse au Loup, on the north shore of the Straits of Belle Isle. Limestone of the Potsdam group.

Collector. J. Richardson.

OBOLELLA. (N. gen.)

Generic characters. Shell ovate circular or subquadrate, convex or plano-convex. Ventral valve with a false area, which is sometimes minute and usually grooved for the passage of the peduncle. Dorsal valve either with or without an area. Muscular impressions in the ventral valve four; one pair in front of the beak near the middle or in the upper half of the shell, and the others situated one on each side near the cardinal edge. Shell calcareous; surface concentrically striated, sometimes with thin extended lamellose ridges.

In general form, these shells somewhat resemble *Obolus*, but the arrangement of the muscular impressions is different. In *Obolus* the two central scars have their smaller extremities directed downwards, and converging towards each other; but in this genus the arrangement is exactly the reverse.

The three species in which I have seen the muscular impressions are the following:

1. *O. chromatica*,—hereinafter described. In this species the central muscular impressions are divergent below.

2. A species which occurs in the well-known deposit of limestone near Troy in the State of New York. This is probably *Avicula* (?) *desquamata* (Hall.) (Pal. N. Y., Vol. I, p. 292, Plate 80, Fig. 3.) In two specimens of this species which I have before me the scars are in the upper part of the valve and diverge below. The small scar on each side close to the margin is visible.

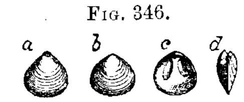
3. A small species from the Potsdam sandstone of the St. Croix River in the Western States, where it occurs associated with the Primordial trilobites described by the late eminent geologist Dale Owen. In this the central scars are close together, one on each side of the median line, and parallel.

The genus appears to be closely allied to *Obolus*, but sufficiently different, on account of the disposition of the muscular impressions, to be classified as a distinct species.

The four species known to me occur in the Primordial Zone, and do not range into the Second Fauna.

OBOLELLA CHROMATICA. (N. sp.)

Fig. 346.



a, Ventral valve; *b*, dorsal; *c*, interior of one of the valves, supposed to be the ventral, showing the muscular impressions; *d*. outline restored from detached valves.

Obolella chromatica.

Description. Broad oval, the rostral extremity obtusely pointed, front broadly rounded, greatest width a little below the middle; both valves rather strongly and uniformly convex, most tumid at about one-third the length from the beak. Ventral valve more acute above than the dorsal, beak depressed below the greatest elevation of the shell, slightly elevated above the margin, with a small area beneath it which is inclined backward at an angle which varies from 45° to 60°. Dorsal valve with an obtusely rounded umbo, the beak scarcely distinct from the cardinal edge and not elevated above the margin. Surface with fine concentric striæ or small minutely rugose ridges of growth, of variable size, from four to eight in one line, often smooth from exfoliation, or wearing. Color of the shell in the reddish limestone a honey-yellow, in gray limestone grayish; when exposed to the weather becomes white and minutely fibrous.

Length and breadth about three lines.

In some specimens the ventral valve is depressed convex, the beak being on a level with the greatest elevation of the shell. The shell is thick and strong, and when well preserved breaks with a granular fracture. When weathered, a tendency to fibrous exfoliation is manifested.

This species is closely allied to the form that is found so abundantly in the Troy limestone, but the muscular impressions in that one are rather closer together and nearer the beak. (At least they are so in the specimens in my possession.)

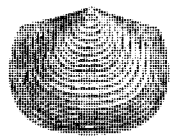
Many of the specimens are a little more obtuse in the upper half than those figured. The individuals are exceedingly numerous and differ little in size.

Locality and Formation. Anse au Loup, on the north shore of the Straits of Belle Isle. In limestone of the Potsdam group.

Collector. J. Richardson.

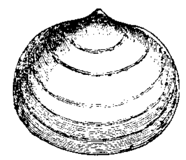
OBOLELLA CINGULATA. (N. sp.)

Fig. 347.



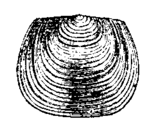
Ventral valve of O. cingulata.

Fig. 348.



Cast of interior of ventral valve.

Fig. 349.



Dorsal valve.

Description. Hinge-line straight, a little less than the greatest width of the shell; sides straight or slightly convex for about one-half the length; anterior angles obtusely rounded; front margin either uniformly convex or with a small portion in the middle somewhat straight. Greatest width a little in front of the middle. Ventral valve strongly and uniformly convex, most tumid about the middle; beak depressed below the greatest convexity of the shell; cardinal edges straight or gently concave, diverging from the beak at an obtuse angle; area unknown. Dorsal valve somewhat flat, most elevated at the beak, in front of which, along the middle of the shell, there is a wide shallow concavity extending to the front margin; on each side of the beak, descending with a somewhat flat slope to the cardinal angles; area unknown, apparently half the height of the ventral area and nearly at right angles to the plane of the margin. Beak erect, obtusely pointed, forming the most elevated part of the shell. Surface with strong concentric sublamellose ridges which do not converge to the beak but terminate on the cardinal edges, their course conforming to the margin of the shell. Four or five ridges in the width of one line.

Length of largest dorsal valve seen six and one-half lines, greatest width eight lines. Length of largest ventral valve in a straight line from beak to front seven lines, width ten lines. The proportional length and width appear to vary. The apical angle of the ventral valve also varies, being in some specimens much more pointed at the beak than in the one above figured. Specimens of all sizes occur from three lines in width upwards.*

Locality and Formation. Anse au Loup, on the north shore of the Straits of Belle Isle. In limestone of the Potsdam group.

Also abundantly in the condition of casts one and one-half miles east of Swanton, in Vermont.

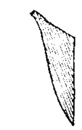
Collectors. J. Richardson, Dr. G. M. Hall, Rev. J. B. Perry.

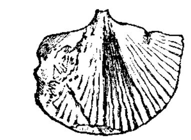
* Since the above was written, I have examined many casts of the interior of this species, and am inclined to the opinion that it is generically distinct from *Obolella chromatica.* From the very considerable elevation of the beak the dorsal valve must have an area and probably a foramen. In one specimen there are two large oval impressions faintly impressed, but still distinctly visible. There is no trace of the lateral scars; and the form, notwithstanding the characters of the surface, conveys the idea of an *Orthisina.* Should, upon further examination, my suspicions turn out to be well founded, I shall call the genus KOTURGINA, after the celebrated European naturalist, KOTURGA.

ORTHISINA FESTINATA. (N. sp.)

Description. Subquadrate or semi-oval, hing-line equal to the greatest width of the shell. Ventral valve subpyramidal, beak elevated, surface with a straight or slightly convex slope in all directions to the margin, area triangular, a little inclined backwards, foramen about as wide as high, closed by a convex deltidium which is perforated at the beak. Dorsal valve nearly flat. Surface with angular bifurcating ribs, five or six in the width of two lines at the margin, crossed by fine concentric striæ, of which there are from seven to ten in one line.

Fig. 350. Fig. 351. Fig. 352.





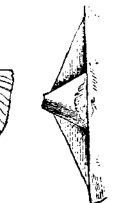


Fig. 350. Side view of O. festinata.
Fig. 351. Ventral valve.
Fig. 352. Area of ventral valve.

Width on hinge-line from ten to fifteen lines; length about one-third less than the width. Height of beak of central valve from two to three lines.

Both valves show longitudinal undulations radiating from the beak to the margin.

This species closely resembles some of the ordinary forms of the genus, but differs internally from any known to me in the Second Fauna in the absence of the dental plates, no traces of which can be perceived in the casts.

Locality and Formation. One and one-half miles east of Swanton, in Vermont. Potsdam group.

Collectors. Dr. G. M. Hall, and Rev. J. B. Perry.

CAMERELLA ANTIQUATA. (N. sp.)

Description. Ovate or subcircular beaks, obtusely pointed (as seen in the cast), both valves moderately or rather strongly convex. Surface with from eight to ten small rounded ribs which do not reach quite to the beaks.

Fig. 353.

Camerella antiquata.

Some of the specimens are proportionally more elongated than others. The front margin appears to be always broadly rounded, and the greatest width at about one-fourth the length from the front margin.

Length from four to six lines; width either equal to or a little less than the length.

This species resembles *C. varians* of the Chazy, but is more numerously ribbed.

Locality and Formation. One and one-half miles east of Swanton, Vermont, in the Potsdam group.

Collectors. Rev. J. B. Perry, Dr. G. M. Hall.

OTHER SPECIES OF BRACHIOPODA.

In addition to the above there are in the sandstone of Vermont, one mile south of the Province line, two other species, one of which appears to be an *Orthisina*, about the same size and shape as *O. festinata*, but more finely ribbed, and an *Orthis*, somewhat like *O. perveta* of the Chazy.

At Anse au Loup there are also two species of *Orthis*, and apparently one *Orthisina*, all different from the Vermont species.

CRUSTACEA.

PARADOXIDES THOMPSONI.* (Hall, sp.)†

Olenus Thompsoni (Hall), *12th Reg. Rep. N. Y.*, p. 59; 1859.
Barrandia Thompsoni (Hall), *13th Reg. Rep. N. Y.*, p. 116; 1861.
Paradoxides Thompsoni (Emmons), *Man. of Geol.* p. 280; 1860.
Paradoxides Thompsoni (Barrande), *Bul. Geo. Soc. France*, 2d series, Vol. 18, p. 276; 1861.

A well preserved head of this species was collected in the limestone at Anse au Loup.

PARADOXIDES VERMONTANA. (Hall, sp.)

(The synonomy of this species is the same as P. Thompsoni.)

Several very good specimens of the glabella and head were collected in the limestone of Anse au Loup. It seems to be more abundant there than *P. Thompsoni.*

CONOCEPHALITES MISER.

Description. Glabella elongate, conical, very convex, most elevated at about the mid-length, slightly narrowed at the neck segment, widest in the middle, narrowly rounded in front, well defined all round by the dorsal furrows. Neck segment strongly convex and bearing a short broad-based spine directed upwards and backwards. Neck furrow extending all across; the posterior glabellar furrow well defined across, forming an obtuse angle backward in the median line; median glabellar furrow also running across, but not so strongly defined as the posterior; anterior furrows extending one-third across.

Fig. 354.

C. miser.

Length of glabella, two lines; width in the middle, about half the length.

There is no described species to which this one bears any close relation, on account of the peculiar character of the posterior and median furrows running quite across the glabella.

Locality and Formation. Anse au Loup, on the north shore of the Straits of Belle Isle. In limestone of the Potsdam group.

Collector. J. Richardson.

CONOCEPHALITES ADAMSI. (N. sp.)

Conocephalus (Adams.) *Silliman's Am. Jour. of Science*, 2nd series, Vol. 5, p. 109; May, 1848.
Conocephalites (Billings.) *In same Journal*, 2nd series, Vol. 32, p. 232; Sept., 1861. *Also in Can. Nat. and Geol.* Vol. 6, p. 324; Aug. 1861.

Description. Head broad, semi-circular, moderately convex; glabella oblong-conical, nearly two-thirds the whole length of the head, the front obtusely rounded or somewhat straight, the anterior angles narrowly rounded, the sides nearly straight from the anterior angle to the neck furrow, just in advance of which is the widest part. The neck furrow well defined all across; the glabellar furrows indistinct; the dorsal furrow is well defined all round the glabella. The cheeks are moderately tumid: a line drawn across the glabella about the mid-length would pass through the eyes. The distance of the eye from the dorsal furrow is equal to the greatest width of the glabella; the eye appears to be very small. The margin in front of the glabella is equal in width to about one-third the whole length of the head; it is bordered by an obtuse narrow elevated rim, just within which is a grave which is more deeply impressed on each side than directly in front of the glabella, there being at this place a gently convex elevation resembling that which occurs in Barrande's species, *C. Sulzeri* and *C. coronatus.* The ocular ridge is well defined where the surface is preserved, but is rarely visible in the sandstone casts. Most of the specimens are distinctly carinate along the median line of the glabella.

Fig. 355.

C. Adamsi.

*For description of this fossil, see p. 369, and Pl. XIII, Fig. 1, of this Report.—A.D.H.

† In a Postscript to the 14th Regent's Reports, dated October, 1861, which I have seen in the form of a single loose sheet, Professor Hall proposes to change the generic name of these species to *Olenellus.* If the genus should turn out to be distinct from *Paradoxides*, I shall be most happy to adopt the name.

It is possible that there may be a median tubercle on the neck segment, but none of our specimens have this part sufficiently well preserved to show it.

The following are the dimensions of a specimen of the average size: Length of head five lines; length of glabella three and one-fourth lines; greatest width of glabella two lines; width of glabella at front one and one-fourth lines; distance of eye from side of glabella two lines.

Dedicated to the late Prof. C. B. Adams, State Geologist of Vermont.

Locality and Formation. Highgate, Vermont, in the Potsdam group, about a mile east of the Highgate Springs.

Collectors. Rev. J. B. Perry, Dr. G. M. Hall, and E. Billings.

CONOCEPHALITES TEUCER. (N. sp.)?

Compare *C. Billingsi* (Shumard.) *Silliman's Am. Jour. of Science*, 2d Series, Vol. 32, p. 220; Sept. 1861.

Description. Head semi-oval, glabella conical, convex, well defined all round by the dorsal furrows, about two-thirds the whole length of the head, widest just in advance of the neck furrow; sides gently convex, front neatly rounded, neck furrow well defined all across; posterior furrows commencing at about one-half the length of the glabella, and running inwards and backwards nearly to the neck furrow and one-third across; median furrows curved backwards, and extending one-fourth across; anterior furrows short; ocular ridges well defined; front margin one-third the whole length of head, with a well defined groove running across, in front of which there is an elevated marginal rim, which rises with a flat slope upwards and forwards; the groove across the margin is situated at about one-fourth the distance from the front of the glabella to the elevated edge of the rostrum; the cheeks are moderately tumid; the neck segment is well developed, with a small median tubercle scarcely one-fourth of a line in height, which in some specimens seems to be absent altogether.

Fig. 356.

C. Teucer.

Thorax of thirteen or fourteen segments; axis strongly defined, cylindrical; side lobes about one-third wider than the axis.

The pygidium is very small, being scarcely one-sixth the length of the thorax. The only specimen in which it has been observed attached to the thorax is not sufficiently well preserved to enable me to describe it in detail.

The following are the measurements of two of the specimens: Length of head four and one-third lines; length of glabella three lines; width, just in advance of neck furrow, two and one-third lines, and at one-third the length from front margin two lines.

In a specimen consisting of the thorax and pygidium the whole length is six lines, of which the pygidium occupies apparently a little less than one line. Width at first segment five and one-half lines; width of axis at same place one and one-half lines; width at anterior margin of pygidium about three lines.

The position of the eye is not shown in any specimen that I have seen, but from the width of the portions of the fixed cheeks which remain, it must be distant from the dorsal furrows nearly the width of the glabella.

This species appears to be closely allied to the one above cited from Shumard's paper, so far as the characters of the glabella are concerned. As however the proportions are a little different, I shall dispose of it as above until I can have an opportunity of submitting a specimen to Dr. Shumard.

Locality and Formation. One and one-half miles east of Swanton, in Vermont, in the slates of the Potsdam group.

Collectors. Rev. J. B. Perry, Dr. G. M. Hall, Sir W. E. Logan.

CONOCEPHALITES VULCANUS. (N. sp.)

Description. Head broad, moderately convex; glabella obtusely conical, with the neck segment triangular and extended backwards in the middle; neck furrow not extending across, being interrupted by a strong carina which runs along the median line; dorsal furrow all round, but not sharply defined. Front margin about one-third the length of whole head, with a projecting rim, and a transverse groove situated two-thirds the distance from the front of glabella. Cheeks moderately convex; ocular ridge well defined; a line drawn across the head a little in advance of the mid-length of the glabella, would pass through the eyes; the latter distant from the glabella at least half the whole length of the head. No indications of glabellar furrows visible.

Fig. 357.

C. Vulcanus.

Length of head, four and one-third lines; of glabella, including the backward projecting angle of the neck segment, three lines; width of glabella just in advance of neck furrow two and one-third lines; distance of eye from glabella two and one-fourth lines.

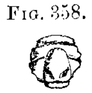
This species differs from *C. Adamsi*, in the character of the neck furrows, and in the greater proportional width of the glabella.

It was found along with *C. Adamsi* in the same beds.

CONOCEPHALITES ARENOSUS. (N. sp.)

Description. Glabella conical about three-fourths the length of the head, convex, well defined by the dorsal furrows all round, neck furrow all across, posterior glabella furrows represented by obscure indentations which appear to be directed obliquely backwards from near the mid-length to near the neck furrow; there appear to be no median and anterior furrows. Front margin with an elevated rostrum and a transverse groove, the latter passing at about one-third from the front of the glabella. Ocular ridge well defined.

Fig. 358.



C. arenosus.

Length of head three and one-third lines; of glabella two and one-half lines; width of glabella at base one and two-thirds lines; at one-third the length from front one and one-third lines.

Another head is four and one-half lines in length. The characters of the impressions, taken to be the posterior glabella furrows, are not well ascertained.

Locality and Formation. In thin-bedded, flaggy sandstone by the side of the road leading from Moore's Corners in St. Armand to Saxe's Mills in Highgate, Vermont, about one mile south of the Province line. Potsdam group.

Collector. E. Billings.

BATHYURUS SENECTUS. (N. sp.)

Description. Glabella subcylindrical, clavate, strongly convex, one-fourth wider at the front margin than at the neck segment, sides nearly straight, front obtusely rounded and presenting a strong convex elevation, neck furrow extending all across, three pairs of glabella furrows represented by small but distinct and obtuse indentations in the sides. Fixed cheeks, rather strongly convex. Eyes of moderate size, semicircular; a line drawn across the head at about one-third the length of the glabella from behind would pass through them, and they are distant from the side of the glabella about the width of the neck segment. The front of the neck is surrounded by a narrow border which appears to be flat; there appears to be some evidence of a spine on the neck segment.

Fig. 359.

Fig. 360.

Fig. 359. Head of *B. senectus.* Fig. 360. Supposed pygidium of the same.

The pygidium found in the same fragment of stone with one of the specimens of the glabella of this species is in all general characters that of a *Bathyurus.* It is semicircular, convex, axis cylindrical, strongly convex, terminating behind with an abruptly rounded descent, six annulations, the first three or four most strongly defined. The lateral lobes have four segments each, separated by strong rounded furrows; there is a narrow entire margin all round with a distinct groove inside, which appears however to be interrupted at the end of the axis.

The dimensions of the most perfect specimens are as follows:

Glabella, length three and one-half lines; width at neck segment one and one-half lines, at the front two lines; distance of the eye from the side of the glabella one and one-half lines. The eye appears to be about three-fourths of a line in length.

Pygidium, length three lines; width at anterior margin five and one-half lines; width of axis one line.

Locality and Formation. Anse au Loup, on the north shore of the Straits of Belle Isle. Limestone of the Potsdam group.

Collector. J. Richardson.

BATHYURUS PARVULUS. (N. sp.)

Description. Glabella cylindrical, strongly convex, much elevated above the fixed cheeks, uniformly arched from the front margin for half the length backwards, very slightly narrower at neck segment than at front margin; sides straight, nearly parallel, and distinctly defined by the dorsal furrows. Neck furrow extending all across, posterior glabella furrows indicated by a barely perceptible indentation on each side; no anterior furrows. Front of head surrounded by a narrow flat margin. Eyes distant from the sides of the glabella about the width of the neck segment.

Fig. 361.

B. parvulus.

On a side view the head has a convexity equal to about one-quarter of a sphere. Length of head two and three-fourths lines; width of glabella one and one-half lines; width of the flat border surrounding the front of the head about one-third of a line.

A line drawn across the head at about one-third of the length from the posterior margin of the glabella would pass through the centers of the eyes. The eyes appear to be about one-third of a line in length.

This species differs from *B. senectus* in the almost total absence of glabellar furrows, and in the nearly equal width of the glabella throughout its whole length.

Locality and Formation. Anse au Loup, on the north shore of the Straits of Belle Isle. In limestone of the Potsdam group.

Collector. J. Richardson.

SALTERELLA. (N. gen.)

Generic characters. Small slender elongate conical tubes, consisting of several hollow cones placed one within another, the last one forming the chamber of habitation of the animal. The cross section of these tubes is circular or subtriangular, and they are either straight or gently curved; the surface is concentrically or longitudinally striated.

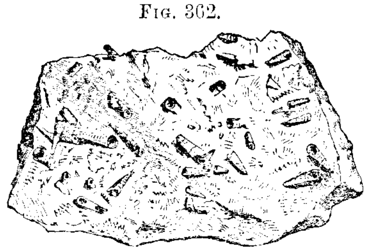
I think these fossils, although no doubt allied to *Serpulites*, sufficiently different therefrom to constitute a distinct genus. Their structure is so compact that they are seldom found compressed, while all species of *Serpulites* are almost invariably in that condition, showing that they consist in general of something more like a membraneous sack than a hard-shelled tube.

This genus is dedicated to J. W. Salter, Esq., Palæontologist of the Geological Survey of Great Britain.

SALTERELLA RUGOSA. (N. sp.)

Description. This little species is straight, conical, tapering uniformly to an acute point. Length from two to four lines, the greater number of the specimens being under three lines; diameter at the larger extremity one line in a specimen four lines in length; the smaller ones are often a little more obtuse. Aperture circular, equal to about three-fourths the whole diameter. It is not certain that in any of the specimens observed the surface is preserved; they all appear to be divested of the outer covering, and exhibit from four to six imbricating sharp annulations in the length of one line, the edges towards the larger end. These are doubtless the exposed edges of the several sheaths of which the tube is composed. They are usually straight, but some are slightly curved.

Fig. 362.



A piece of limestone with S. rugosa.

This species must be closely allied to *Serpulites Macullochi* (Salter), but upon an average they are smaller than those figured by Salter in the Jour. Geol. Soc., Vol. 15, Pl. 13, Fig. 31.

Locality and Formation. Anse au Loup on the north shore of the Straits of Belle Isle. In limestone of the Potsdam group.

Collector. J. Richardson.

SALTERELLA PULCHELLA. (N. sp.)

Description. Elongate, conical, gently curved, from six to eight lines in length and from one line to one and a half in width at the aperture. Surface ornamented with small encircling striæ just visible to the naked eye.

This species is larger than *S. rugosa*, always a little curved, not so abundant, and when weathered does not present the sharp imbricating annulations of that species.

Locality and Formation. Same as *S. rugosa*, but apparently not in the same bed, as the two species are not found together in the same fragments of rock.

SALTERELLA OBTUSA. (N. sp.)

Description. From six to eight lines in length; diameter at aperture about three lines. The transverse section is always sub-triangular, and in some of the specimens one side appears to be flat like a *Theca*, and I would refer it to that genus only that the tube is composed of successive layers. None of the specimens are perfect, but the form is sufficiently different from that of the other two to indicate a distinct species.

Locality and Formation. Same as the preceding, but not associated with *S. rugosa*, although it occurs in the same fragments of rock with *S. pulchella*.

II. ON SOME NEW SPECIES OF FOSSILS FROM THE CALCIFEROUS, CHAZY, BLACK RIVER, AND TRENTON FORMATIONS.

EOSPONGIA. (N. gen.)

Astylospongia (pars.)—(Roemer.) *Die Silurische Fauna des Westlichen Tennessee*, p. 7; 1860.

Generic characters. Subglobular, pyriform or subhemispherical sponges, not free, with an internal arrangement of pores (sometimes reticulated), radiating irregularly from the central axis; cup of variable depth.

Dr. Ferdinand Roemer in his beautiful work on the Silurian Fauna of Western Tennessee, has described three genera of Silurian sponges, *Astylospongia*, *Palæomanon* and *Astræospongia*. The first of these he says consists of free sponges, hence the generic name. We have several species in the lower Silurian rocks of Canada, which were evidently attached and not free. Most of the specimens have a well developed pedicle. Some of the others which exhibit no pedicle evidently attached themselves while young to some cylindrical body and grew around it. We have several with the stalk of a crinoid passing quite through either in the center or a little on one side. Others are perforated through the center as if they had grown around some upright slender body, which has disappeared during the natural process of fossilization. Those with the stalks of crinoids passing through them could not have been free, and the others with the central perforation appear to be of the same species. The structure and general form does not differ from those which exhibit perfect evidence of a pedicle. I propose therefore to separate the species here mentioned from *Astylospongia*, and arrange them under the name of *Eospongia*.

I shall place a new species from the Trenton limestone, corresponding in form to Roemer's *A. inciso-lobata*, in *Astylospongia*.

EOSPONGIA ROEMERI. (N. sp.)

Description. Elongate, pyriform or club-shaped; the internal structure in polished sections shows numerous circular tubes, those in the central part of the mass the largest.

The best preserved specimen that I have observed is five and one-half inches in length and three inches in diameter, at two inches from the top. The larger extremity is rounded, with a small depression one inch wide and one-half of an inch in depth in the center. It tapers gradually from three inches to a diameter of one and one-half inches at the small end where it is broken off. The pores, as shown in a polished transverse section, are from one-half of a line to two lines in diameter.

Dedicated to Dr. FERDINAND ROEMER.

Locality and Formation. Mingan Islands, Chazy limestone.

Collectors. J. Richardson, Sir W. E. Logan.

EOSPONGIA VARIANS. (N. sp.)

Description. This species is depressed, turbinate, expanding from the obtusely pointed pedicle to a width of from two to three inches, at a height of from one to two and one-half inches. The upper margin is obtusely rounded. The width of the cup is about one-third of the whole diameter, and about one-half or three-fourths of an inch deep, rounded at the bottom, and with a thick rounded margin. The greatest width of the species is in general near the top, but in those which have grown around the stalk of a crinoid there is a depression below as well as above, so that it is often difficult to say which is the cup or which the base. The transverse polished section shows numerous radiating tortuous channels, often branching from one-half to one line in diameter, and usually distant once or twice their width. The vertical section shows other channels ascending and sloping outwards. The weathered surfaces are irregularly striated with obscure rounded, often interrupted, radiating ridges of from one-half to one line wide.

Some of the specimens are nearly flat, but in general they are obscurely turbinate or very depressed pyriform.

Locality and Formation. Mingan Islands, Chazy limestone.

Collectors. Sir W. E. Logan, J. Richardson.

ASTYLOSPONGIA PARVULA. (N. sp.)

Description. Small, subglobular, the sides grooved by from five to seven deep furrows, which divide it into as many lobes. The furrows are about half the width of the lobes. There is no trace of either a cup or a pedicle at either extremity. The individuals are from one-fourth to three-fourths of an inch in diameter.

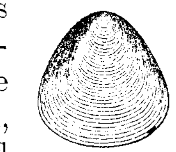
This species is of the same form as Roemer's *A. inciso-lobata*, with the exception of the absence of the central depression or cup. It is also less than half the diameter of that species.

Locality and Formation. City of Ottawa. Trenton limestone.

Collector. E. Billings.

LINGULA PERRYI. (N. sp.)

Fig. 363.



Lingula Perryi. Dorsal valve.

Description. Dorsal valve triangularly oval, the front margin gently convex or nearly straight, the anterior angles broadly rounded, the apex obtusely pointed; the sides from the apex for one-half the length, or a little more, gently convex or somewhat straight and diverging at an angle of about 60°. The beak is rounded, prominent and situated about one-fourth of a line from the margin of the apex. The most convex part of the shell is at about one-fifth the length from the beak; from this point the surface descends with a uniform, gentle and very slightly convex slope in all directions to front margin and anterior angles and half of the sides; in the posterior or upper half with an abrupt slope, becoming concave on each side of the beak. Surface ornamented with fine lamellose ridges distant from each other two or three in one line.

Length of specimen nine lines; greatest width, at one-fourth the length from front margin, about eight lines.

The shell appears to be smooth between the lamellose concentric striæ, but in more perfect specimens finer striæ may exist. The striæ become more crowded in the upper part, where they curve round to the beak.

This beautiful *Lingula* has somewhat the appearance of *Lingula Belli* of the Chazy limestone. That species, however, usually exhibits three flat slopes, one to the anterior margin and one to each side.

Dedicated to the discoverer, Rev. J. B. PERRY, of Swanton, Vermont.

Locality and Formation. Limestone at Highgate Springs, Vermont, apparently of the age of the Black River.

Collectors. Rev. J. B. Perry, and Dr. G. M. Hall.

LITUITES IMPERATOR. (N. sp.)

Description. Very large, the coiled portion alone being ten and one-half inches across. The first two whorls are two and one-eighth inches and the first three four and one-half inches across. The first three are coiled in contact; after which the whorls begin to separate and at the completion of the fourth are distant about one-quarter of an inch. The last whorl is then produced nearly in a straight line for about two inches, after which (in the only specimen collected) it is not preserved. The dorso-ventral diameter of the tube where broken off is almost four and one-half inches. The distances of the septa vary greatly. In the commencement of the third whorl there are three in one inch, but they gradually become more distant until at the end of this whorl there are only two in one inch. The distance then diminishes, and at the middle of the fourth whorl there are four in one inch. (These measurements relate to the outer side.) Beyond this they are not seen, but the siphuncle is preserved to the end of the fourth whorl and shows the traces of nine septa in the last inch. The siphuncle is exposed in the specimen in two places, both in the fourth whorl. In the first quarter of the length of this whorl it is concealed. In the second quarter it is laid bare for a length of five and one-half inches. It is here four lines in diameter, and its position is as nearly as can be, central. In the last quarter of the whorl there is another exposure of about four inches; its diameter being five lines, and its position, where last seen, two and one-half inches from the ventral or outer margin, and one and one-quarter inches from the dorsal or inner margin. The position therefore of the siphuncle in this species varies in different parts of the same individual.—This agrees with Barrande's observations on *Orthoceras mundum*, in which the siphuncle passes from one side to the other in such a manner that ten or twelve species might be made out of different fragments of the same individual specimen, provided the position of the siphon were alone to be taken into account and the pieces described by different observers without a knowledge of their connection.*

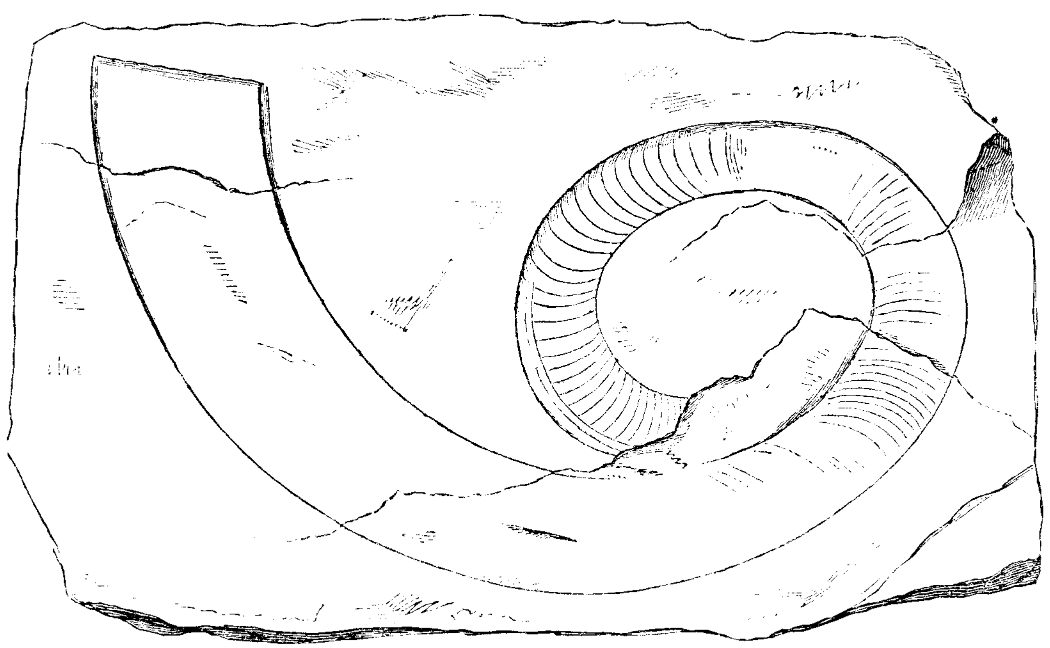
The only specimen collected is firmly imbedded in the limestone matrix, and is worn away so as to exhibit a complete section along the plane of the coil, showing all the whorls and the siphuncle as above mentioned. The character of the surface cannot thus be observed. But judging from the appearance of the shell as seen in the section, the last whorl is crossed by wide shallow undulations, but no traces of these can be seen on the inner whorls, where the shell is also visible.

Locality and Formation. Phillipsburgh, in the County of Missisquoi, Canada East.—In the upper part of the Calciferous formation.

Collector. Dr. P. J. Farnsworth.

LITUITES FARNSWORTHI. (N. sp.)

Fig. 364.



†Lituites Farnsworthi.

Description. Tube very slender, forming about three complete whorls; section circular or very nearly so; siphuncle small, close to the shell in the median line on the outer or ventral side; septa generally arched and numerous; chamber of habitation deep.

* Barrande. In *Bronn's Neues Jahrbuch*, 1859, p. 608.

†Since the above was engraved, better specimens have been received. The figure does not show the many close septa near the outer chamber, which can be made out, although indistinctly, in the specimen.

In the best preserved specimens the first two whorls are in contact and make a coil one inch across. The whorls then commence to separate, and become more and more distant until at the completion of the third the distance is from one and one-half to two and one-quarter inches. Where the whole spire is four and one-half inches across, the diameter of the aperture is one inch; at three and one-half inches it is nine lines. There are usually from eight to twelve septa in half an inch, but the distance is variable in the same specimen. In the one figured there are five or six in half an inch in the latter part of the second and commencement of the third whorl, but further on towards the outer chamber there are twelve or fifteen in the same distance. The siphuncle is about three-quarters of a line in diameter and about the same distance from the shell. The chamber of habitation appears to be three or four inches deep. No part of the free portion is straight, the curve continuing, although becoming gradually less quite to the aperture. Surface of shell unknown.

This species differs from all known American species in being more slender, and in having more numerous septa.

Dedicated to the discoverer, Dr. P. J. Farnsworth, M.D., Phillipsburgh, Canada East.

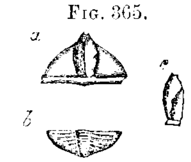
Locality and Formation. Phillipsburgh, in the County of Missisquoi, Canada East. In the upper part of the Calciferous formation.

Collectors. Dr. P. J. Farnsworth, E. Billings.

AMPYX HALLI. (N. sp.)

Description. Head somewhat triangular or semioval. Glabella elongate oval, terminating in front with an acute elevated rostrum, the length of which is not known, and truncated behind by the neck furrow, narrowly convex and rather sharply carinated along the median line. Glabellar furrows represented by two obscure indentations on each side, the posterior at a little less than one line from the neck segment and the anterior about two lines; the latter are deep pits situated in the dorsal furrow or just in the angle formed by the junction of the base of the glabella with the fixed cheeks. The neck segment is a flat plate inclining upwards and backwards at an angle of about 45°. The neck furrow is well defined all across the whole width of the head, being least distinct in passing over the posterior part of the glabella.

Fig. 365.



Ampyx Halli. *a*, head; *b*, pygidium; *c*, side view.

Pygidium semioval with a flat border all round abruptly bent down at nearly a right angle. Axis conical, moderately convex, extending the whole length and causing a slight projection in the posterior margin. Side lobes nearly flat, with five or six flat ribs each with a fine pleural groove extending the whole length. On the axis there appear to be ten or twelve closely crowded annulations occupying five-sixths of the length, the apex being apparently smooth. On approaching the margin the side ribs seem to curve a little forward. Length of head, excluding the rostrum, three and one-half lines, measured along the base of glabella. Width of glabella at neck segment one and one-half lines, and just in front of the anterior pits two lines; elevation at neck segment less than one line, and at front of head, so far as seen, about two lines. These measurements refer to the largest head seen.

No perfect head has been collected, and I cannot therefore give the length of the rostrum or movable cheeks.

Dedicated to Dr. G. M. HALL, of Swanton, Vermont.

Locality and Formation. St. Dominique, in the County of Yamaska, Canada East, and at Highgate Springs in Vermont. In the Chazy limestone.

Collectors. J. Richardson, Dr. G. M. Hall, and Rev. J. B. Perry.

ERRATA.

On page 176, 5th line from bottom, for "ham," read *horn.*
" 757, 23d line from top, for "5," read 25.
" 766, 21st line from top, for "J. R. Barnes," read *W. P. Barnes.*
" 881, 14th line from top, for "five thousand," read *three thousand.*

GLOSSARY.

Abnormal—*ab*, from, *norma*, rule. Not conformable to rule.

Abnormous—Out of rule; misshapen.

Acephalous—(a-kef-al-us.) *a*, without, *kephale*, head. Without a head; headless.

Actinolite—*aktin*, a ray, *lithos*, a stone. A variety of hornblende which usually occurs in fascicular crystals.

Aculeatus—*aculeate*, having a sharp point.

Acuminata—*acuminate;* pointed; peaked.

Acuta—Acute; sharp pointed.

Acuticosta—*acutus*, pointed, and *costa*, rib. Having pointed ribs or sides.

Acutiloba—*acutus*, pointed, *loba*, a lobe. Having sharp or pointed lobes.

Adult—*adolesco*, I grow. Full grown.

Agate—*agathos*, good, precious. An aggregate of certain silicious minerals, chiefly chalcedony, variously colored.

Agglomerate—*agglomero*, I wind up. To gather together.

Agglomeration—A mass made up of parts gathered together.

Agglutinated—*ad*, to, *gluten*, glue. United together; adhering.

Alæformis—*ala*, wing, *forma*, shape. Wing-shaped.

Albite—*albus*, white. A variety of feldspar.

Algæ—Lat. plur. of *alga*. Seaweed; systematic name of a family of plants.

Alluvial—Of the nature of alluvium.

Alluvion, *Alluvium*,—*alluo*, I wash upon. Gravel, sand, mud, and other transported matter washed down by rivers and floods upon land not permanently submerged beneath water; a deposit formed from transported matter.

Alpine—Belonging or relating to the Alps.

Alumina—*alumen*, alum. Pure argil; the basis of alum; one of the earths.

Aluminous—Of the nature of alumina or clay.

Alveolatus—*alveolate.* Having the surface covered with numerous depressions, comparable to the alveoli or sockets of the teeth.

Amblypterus—*amblus*, obtuse, *pteron*, wing. A fossil fish.

Ammonia—Relating to Ammon, a name of Jupiter. Specific name of a fossil shell.

Ammonis—Lat. Genitive case of Ammon, a name of Jupiter.

Ammonite—Generic name of a fossil.

Amorphous—*a*, without, *morphe*, form. Shapeless.

Amphibole—*amphibolus*, equivocal. Variety of hornblende.

Amplexus—*amplecto*, I embrace. Generic name of a fossil.

Ampullaria—*ampulla*, a round, swelled out bottle. Name of a genus of snails.

Amygdaloid—*amugdalon*, an almond, *eidos*, form. Almond-shaped. Applied to certain rocks in which other minerals are occasionally imbedded like almonds in a cake.

Analogy—*ana*, between, *logos*, reason. Resemblance or relation things bear to each other, although not exactly alike in all respects.

Anastomosed—Branching and interlacing.

Andalusite—A mineral first observed in Andalusia, in Spain. It is very hard and infusible and consists chiefly of alumina and silica. Chiastolite.

Angle of dip—Angle formed with plane of the horizon.

Angulated—Formed with angles or corners.

Anhydrous—*a*, without, *udor*, water. Without water. Applied to salts and certain acids when deprived of water.

Annelides—Animals having an external integument formed of rings.

Annular—*annulus*, ring. Shaped like a ring.

Annularia—*annulus*, ring. Generic name of a fossil plant.

Anodonta—*a*, without, *odous*, tooth. Systematic name of a kind of mussel.

Anticlinal axis, *Anticlinal line*,—*anti*, against, *klinein*, to incline. An imaginary line, from which strata, dipping in opposite directions, incline.

Anthracite—*anthrax*, charcoal. Mineral charcoal. A kind of stone coal difficult to inflame.

Apex—Summit or tip of the spire of a shell.

Appressed—Pressed closely together.

Aquatic—*aqua*, water. Relating or belonging to water.

Arborescent—*arbor*, a tree. Branching like a tree.

Arcuata—Arched; bent like a bow.

Arenaceous—*arena*, sand. Sandy; of the nature of sand.

Argentiferous—argentum, silver, *fero*, to produce. Producing silver.
Argil—argilla, clay. Old name of alumina.
Argillaceous—Of the nature of clay.
Argilo-arenaceous—Partaking of the nature of both clay and sand.
Articulation—articulatus, a joint. A joint betwixt bones or portions of crustaceans.
Articulata—Having joints like those of insects.
Asaphus—asaphes, obscure. A name devised to express the obscure nature of a genus of trilobites, fossil crustaceans.
Asbestus—asbestos, unconsumable. A fibrous, soft mineral, composed of easily separable filaments of a silky luster. It consists essentially of silica, magnesia, and lime.
Astarte—Name of a genus of fossil bivalve shells.
Astrea—aster, a star. A genus of polyparia.
Attenuated—Made slender or thin.
Augite—auge, luster. A mineral, the same as pyroxene.
Augitic-porphyry—Crystals of Labrador feldspar, and of augite in a green or dark-gray base.
Avicula—avis, a bird. Name of a genus of bivalve mollusks.
Axis of elevation—Line of elevation.
Baccilar—bacca, a berry. Berry-like.
Balanus—A barnacle.
Basalt—A rock essentially composed of feldspar, and augite of a compact texture, and dark green, gray or black color. It occurs in columnar masses.
Basaltic—Of the nature of basalt.
Base—The opposite extremity from the apex.
Basins—A series of deposits having a trough-like or basin shape.
Basset—Outcrop, or emergence of strata at the surface.
Batracian. (ba-trak-ean)—*batrachos*, frog. A kind of reptile resembling a frog in its mode of organization.
Beach—The washed shore of a sea or lake.
Beak—The continuation of univalve shells in which the canal is situated, or the extreme point of the summit of bivalves.
Belemnites—belemnon, a dart. A genus of fossils dibranchiate cephalopods, the shells of which are chambered and perforated by a siphon, but internal.
Biangulated—Having two angles.
Bicordatus—bicordate. Double heart-shaped.
Bifurcated—bis, two, *furca*, fork. Divided into two branches.
Bioculata—bis, two, *oculus*, an eye. Two-eyed.
Bitumen—pitus, the pitch-tree; because it resembles pitch. A variety of inflammable mineral substances, which, like pitch, is included under this term.
Bitumenized—Converted into bitumen.
Bituminous—Of the nature of bitumen.
Bituminous shale—A slaty rock containing bitumen.
Bivalve—bis, two, *valvæ*, doors. Shells composed of two pieces united by a hinge are termed bivalves.
Blende—Sulphuret of zinc; a common shining zinc ore.
Bosse—A hillock; a rounded projection or elevation.
Botryoidal—botrus, a bunch of grapes, and *eidos*, resemblance. Clustered like a bunch of grapes; covered with smooth, rounded masses.
Brachiopod. (bra-ke-o-pod)—*brachion*, arm, *pous*, foot. A mollusk with a two-lobed mantle and bivalve shell.
Brachyphyllum—brachus, short, *phullon*, leaf. A genus of fossil plants.
Breccia—A rock composed of an agglutination of angular fragments.
Brevifolia—brevis, short, *folium*, leaf. Short-leaved.
Buccinum—A trumpet or horn. Name of a genus of mollusks.
Calamites—kalamos, a reed. Common fossil plants in the coal strata.
Calc-sinter—sintern, to drop. A German term for limestone deposited from springs and waters containing it. Travertin.
Calcareous—calx, lime. Containing lime.
Calcareous grits—Sandy beds, intermixed with calcareous matter.
Calceola—calceolus, a little shoe. A fossil bivalve shell.
Calciferous—calx, lime, *fero*, I bear. Containing lime.
Calcined—Converted into calx or a friable substance by the action of fire.
Calcination—The reduction of bodies to a calx or friable condition by the action of fire.
Calc spar—Calcareous spar.
Calymene—kekalumene, concealed. A name of a genus of trilobites.
Canaliculated—Shaped like a pipe or gutter.
Cannæformis—canna, a reed, *formis*, form. Reed-shaped.
Carbon—carbo, a coal. The pure inflammable principle of charcoal. In its state of absolute purity, it constitutes the diamond.
Carbonate—A compound of carbonic acid with a salifiable base; carbonate of lime, for example, is a compound of carbonic acid with lime.
Carbonaceous—Belonging or relating to carbon.
Carbonic acid—An acid, compounded of carbon and oxygen.
Carboniferous—carbo, a coal, *fero*, I bear. Containing carbon.
Carbonized—Converted into carbon.
Carburet—A combination of carbon with a metal or other substance. Steel and black lead are carburets of iron.
Carbureted—Converted into a carburet; containing carbon.
Cardinal—cardo, hinge. Relating to the hinge of a shell.

Cardium—A cockle. A genus of bivalve shells.
Carinata—carina, a keel. Carinate; having a keel-like elevation.
Carniverous—carno, flesh, *voro*, I eat. Flesh-eating.
Caryophyllia—caryophyllus, the garden pink. A genus of Madrepora.
Cascade—A cataract; a water-fall.
Catenipora—catena, a chain, *pora*, pore, Generic name of a polyp; chain coral.
Catylus or *catillus*—A little dish. A genus of fossil shells.
Caudatus—Having a tail.
Cavernous—cavus, a hollow. Containing hollows; excavated.
Cemented—Joined together by cement.
Centigrade (Thermometer)—*centum*, hundred, *gradus*, a degree. Division into a hundred parts. The scale of the centigrade thermometer is made by dividing the space between the points of freezing, and boiling water, into one hundred parts or degrees.
Cephalaspis (kef-al-a-spis)—*kephale*, head, *aspis*, shield. A genus of fossil fishes.
Cephalopod (kef-alo-pod)—*kephale*, head, *podos*, foot. A mollusk which has the head situated between the body and feet.
Cerithium—A genus of turriculated univalve mollusks, both recent and fossil.
Ceroid—keros, wax, *eidos*, resemblance. Wax-like.
Cetacea—ketos, a whale. Name of an order of mammals.
Cetaceous—Relating or belonging to cetacea.
Chalcedony—kalkedon, Chalcedon, in Asia. A semi-transparent silicious mineral, apparently formed by the infiltration of silicious matters in a state of solution.
Chalk—Earthy carbonate of lime.
Chalk marl—Marl belonging to the cretaceous formation.
Chambered shells—Those divided into cells by septa or partitions.
Chelonians—chelone, a sea-tortoise. Animals of the tortoise tribe.
Chert—A silicious mineral resembling flint. It is usually found in limestone.
Chlorite—chloros, green. A soft, green, scaly mineral, slightly unctuous.
Chloritic schist—Schist containing chlorite.
Chrome—chroma, color. The oxyd of a metal called chromium.
Cicatrix—A scar.
Cinders—Matters remaining after combustion.
Clavellata—clavulus, a little nail. Marked by little projections or points; knotted.
Cleavage—The mechanical division, the laminæ of rocks and minerals, to show the constant direction in which they may be separated.
Clymenia—klumenon, the marigold (?). A genus of fossil cephalopods of the Devonian system, with a chambered shell analogous to that of the ammonite.
Coal measures—The formations in which coal is found.
Coleoptera—koleos, sheath, *pteron*, wing. Name of an order of insects.
Columba—A dove. Specific name of a fossil shell.
Columella—The upright pillar in the center of most univalve shells.
Columnare—Columnar. In the form of a column.
Comminuted—Fractured into small pieces.
Comparative anatomy—The comparative study of the various parts of the bodies of different animals.
Concentric—Having a common center.
Concentricus—Concentric.
Conchiferous (con-kif-erous)—*concha*, shell, *fero*, I bear. Shell-bearing.
Conchoidal—Shell-like.
Concretionary—Made up of concretions.
Conduit—A water-pipe; a canal.
Conformable stratification—When the strata are parallel to each other.
Congeners—con, with, *genus*, race. Species belonging to the same genus.
Conglomerate—conglomero, I heap together. A rock composed of pebbles cemented together by another mineral substance, either calcareous, silicious, or argillaceous.
Conifer—conus, a cone, *fero*, I bear. A tree or plant which bears cones, such as pines, fir trees, &c.
Conoidea—Conoidal. Cone-shaped.
Contemporaneous—con, with, *tempus*, time, Existing at the same time.
Contorted—con, together, *torqueo*, I twist. Twisted together; bent.
Convolute—Rolled together.
Convex—Gibbous. Swelling on the exterior surface into a spherical form.
Coprolites—kopros, dung, *lithos*, stone. Fossil excrements.
Coral—koreo, I ornament, *als*, the sea. The hard calcareous support formed by certain polypi.
Coralline—Belonging or relating to coral.
Cordiform—Heart-shaped.
Cornutus—Horned.
Coronata—Crowned.
Costatus—Ribbed.
Crassatella—A genus of bivalve shells.
Crasus—Thick.
Crater—crater, a great cup or bowl. The mouth of a volcano.
Crenatum—Crenate; having rounded teeth.
Crenulated—Having the edge cut into small scallops.

Cretaceous—creta, chalk. Of the nature of chalk; relating to chalk.

Crinoideæ—krinon, lily, *eidos*, resemblance. A family of radiate animals.

Crocodilian—Any animal of the tribe of crocodiles.

Crop out—When a rock, in place, emerges on the surface of the earth, it is said to crop out.

Crustacean—Any animal of the class of crustacea; a crab.

Cryptogamia—kruptos, concealed, *gamos*, marriage. Name of a class of plants.

Crystal—Ice. Any inorganic solid of homogeneous structure, bounded by natural planes and right lines symmetrically arranged.

Crystalline—Relating to or resembling crystals.

Crystallization—The process of forming crystals.

Cuneiform—Wedge-shaped.

Cuprous—Belonging to copper.

Cupriferous—cuprum, copper, *fero*, to produce. Producing copper.

Cyathocrinites—kuathos, a cup, *krinon*, lily. A genus of crinoideæ.

Cyathophyllum—kuathos, a cup, *phullon*, a flower. A genus of polyparia.

Cycas—A name employed by the ancients to designate a little palm.

Cyclas—kuklos, a circle. A genus of gasteropods.

Cyprea—kupris, Venus. A genus of gasteropod mollusks.

Cypris—kupris, Venus. Name of a genus of crustaceans.

Cyrena—A genus of bivalve mollusks.

Data—datum, given, a gift. Admitted facts.

Debacle—Sudden escape of water from a lake, following a bursting of its barrier.

Debris (de-bree)—Ruins; remains.

Delta—Alluvial deposits at mouths of rivers, like Δ.

Deltoidea—Letter Δ, *eidos*, resemblance. Resembling a delta Δ.

Dendritic—Tree-like; branched like a tree.

Dentatum—Dentate; having sharp teeth.

Denude—denudo, I strip. To lay bare.

Denudation—A removal of a part of the land, so as to lay bare the inferior strata.

Deposition—depono, I let fall. The falling to the bottom, of matters suspended or dissolved in water or other liquid.

Depressed shell—One in which the spire is very flat.

Depressus—Pressed; sunk.

Dessication—The act of drying.

Detritus—Remains of disintegrated rocks

Dextral—Rising from right to left.

Dexter valve—The right valve.

Diallage—diallage, difference. A mineral of foliated structure easily divisible in *one* direction, its natural joints and fractures exhibiting a very *different* luster and appearance.

Diceras—dis, two, *keras*, horn. Generic name of a fossil bivalve.

Dichotomous—Dividing by pairs from top to bottom.

Dicotyledons—dis, two, *kotuledon*, seed lobe. A division of plants, according to the Natural Order.

Digona—dis, two, *gone*, angle. Having two angles.

Dilatata—Dilated; swelled out.

Diluvion, *Diluvium*, } *diluo*, I wash away. A superficial deposit.

Diorite—A variety of trap rock consisting of albite and hornblende.

Dip—Direction of the inclination of strata. "To take a dip," is to measure the degree that a stratum inclines or dips from a horizontal line.

Direction of strata—The strike, or line of bearing.

Discordant stratification—Unconformable stratification.

Discoidal—Resembling a disk.

Disengaged—Separated from; freed.

Disintegrate—de, privitive, *integer*, entire, whole. To separate or break up an aggregate into parts.

Disintegration—The act of separating or dividing a whole into parts.

Dislocate—de, privitive, *locus*, place. To put out of place.

Dislocation—Displacement of a part.

Disposition—dispono, I arrange. Arrangement, method, order.

Disruption—disrumpo, I break off. The act of breaking asunder.

Dissepiments—dis and *sepio*, to inclose. Partitions dividing cells.

Distortion—de, from, *tortum*, twisted. The act of distorting or twisting out of place.

Dolomite—Named after Dolomieu. Magnesian marble; magnesian carbonate of lime.

Dorsal—dorsum, back. Pertaining to the back.

Drift—Superficial deposits composed of gravel, bowlders, sand, clay, &c.

Druses—Cavities in minerals lined with minute crystals.

Echinidæ, *Echinideæ*, } *echinos*, a hedge-hog, *eidos*, resemblance. Systematic name of the order of sea-urchins.

Edentata—Edentate. An order of mammals without teeth.

Edentate—e, without, *dens*, tooth. Without teeth.

Effervescence—efferresco, I grow hot. The commotion produced in fluids by the sudden escape of gas in the form of bubbles.

Effusion—effundo, I pour out. The pouring out of a liquid.

Elegans—Elegant.

Emarginate, *Emarginated*, } Notched upon the edge or margin.

Emboss—bosse, a protuberance. To cover with lumps or bunches.

Encrinites—krinon, a lily. A genus of echinoderms.

Ensiform—ensis, sword, *formis*, form. Saber-shaped.

Entomostracans—entomos, incised, *ostrakon*, a shell. A division of the class of crustacea.

Eocene—eos, dawn, *kainos*, recent. The early or older tertiary strata.

Epoch—The time from which dates are numbered.

Equalis—Equal.

Equisetum—equus, horse, *seta*, hair. A genus of plants.

Erode—erodo, I gnaw. To wear away; to corrode.

Eroded—Worn away.

Erosion—The act of wearing away.

Erosive—Corroding; wearing.

Eruption—e, from, *rumpo*, I burst. The act of bursting from any confinement.

Escarpment—scarpa, sharp, *carpere*, to cut or divide. The steep face often presented by the abrupt termination of strata where subjacent beds "crop out" from under them.

Escharoides—eschara, a fire-place, a gridiron, *eidos*, resemblance. Specific name of a coral.

Euomphalus—eu, properly, *omphalos*, the navel. A gasteropod mollusk of circular form.

Euphotide—A rock composed essentially of feldspar and diallage.

Evolutus—Unfolded.

Excoriation—ex, from, *corium*, skin. An abrasion; mark of a part having been rubbed from the surface.

Exogyra—exo, without, *guros*, circle. Not circular. A genus of unimuscular bivalves, allied to the oyster.

Exudation—ex, from, *sudo*, I sweat. Transpiration.

Exuviæ—The sloughs or cast-skins, or shells of animals.

Fasciculus—A bundle.

Fasciculated—Consisting of little bundles.

Fastigiata—Sharpened at top like a pyramid.

Fault—Interruption of the continuity of strata, with displacement.

Fauna—faunus, the name of a rural deity among the Romans. All animals of all kinds peculiar to a country constitute the *fauna* of that country.

Feldspar—An important mineral composed of silica, alumina, and potash, with traces of lime, and often of oxyd of iron. It enters into the composition of granite.

Feldspathic—Of the nature or belonging to feldspar.

Fenestrules—fenestra, a window. Window-like openings.

Ferruginous—ferrum, iron. Of an iron or iron-rust color.

Filiform—filum, a thread, and *form*. Thread-shaped; slender and of equal thickness.

Fissile—findo, I split. Easily split.

Fissure—A cleft, crack, or narrow chasm.

Flora—flora, goddess of flowers. All the plants of all kinds of a country constitute the *flora* of that country.

Fluviatile—Belonging or relating to a river.

Foliated—folium, a leaf. In form of leaves; leafy.

Foramen—A little opening or perforation.

Foraminifera—foramen, hole, *fero*, I bear. Name of a tribe of minute shells.

Formation—Any group of rocks formed during a particular epoch, or of common origin.

Fossil—fodio, I dig. Any organic body, or the traces of any organic body, whether animal or vegetable, which has been buried in the earth by natural causes.

Fossiliferous—Containing fossils.

Fossilized—Converted into a fossil.

Fumarole—Subterraneous emission of hydrogen gas in consequence of the ebullition of certain sulphurous waters. The hole or orifice through which the gas escapes.

Fusion—The act of melting; state of fusion is being melted.

Fusiforme—Fusiform, spindle-shaped.

Galena—galene, lead-ore. Sulphuret of lead; a compound of sulphur and lead.

Ganöideans—ganos, splendor. An order of fishes having angular scales regularly arranged and entirely covering the skin.

Garnet—A mineral consisting of silicates of alumina, lime, iron, and manganese.

Gas—geist, spirit. The name given to all permanently elastic fluids or airs different from the atmospheric airs.

Gaseous—Of the nature of gas.

Gasteropods—gaster, belly, *pous*, a foot. A class of mollusks which have a ventral muscular disc adapted for creeping; a snail.

Gelatinous—Jelly-like.

Generic—Relating to genus.

Genus—A kindred, breed, race, or family.

Geodes—geödes, earthy. Nodules of iron stone, hollow in the center. Rounded pebbles having an internal cavity, lined with crystals, are also so called.

Geological—Relating to geology.

Geology—ge, the earth, *logos*, discourse. That branch of natural history which treats of the structure of the terrestrial globe.

Geysers—From an Icelandic word, signifying raging or roaring. Celebrated spouting fountains of boiling water in Iceland.

Gibbosity—gibba, a bunch. A protuberance.
Giganteum, } Gigantic.
Giganteus, }
Glaber—Smooth, bald, bare.
Glabrous—Smooth, having a smooth surface.
Glaciers—Masses or beds of ice formed in high mountains, derived from the snows or lakes frozen by the continued cold of those regions.
Globata—Globate, rounded.
Grallæ—Wading-birds.
Granitic—Belonging or relating to granite.
Granular—Consisting of grains.
Granules—Little grains.
Graphite—graphó, I write. A mineral composed of carbon and iron, constituting carburet of iron. It is known as plumbago and *black lead*.
Gravel—Small rounded stones, varying in size from a small pea to a walnut, or something larger.
Greenstone—A tough variety of trap-rock, consisting chiefly of hornblende.
Grit—A coarse-grained sandstone.
Gryphea—grupos, incurved. A genus of fossil bivalves.
Gypseus—Of the nature of gypsum.
Gypsum (jip-sum)—Native sulphate of lime. The transparent varieties constitute *selenite*. Gypsum is converted into plaster of Paris by heat.
Helix—elix, a spiral. A gasteropod mollusk; a snail.
Heterocercal—eteros, opposite, *kerkos*, a tail. Having the spine prolonged into the tail.
Heteroclitical, } Reversed. Applied to shells whose
Heterostrophe, } spires turn in a contrary direction to the usual way.
Hinge—The point at which bivalve shells are united.
Hippopotamus—ippos, horse, *potamos*, a river. The river horse.
Hornblende—A mineral of dark green or black color, abounding in oxyd of iron, and entering into the composition of several of the trap rocks.
Hornblende schist—A slaty variety of hornblende.
Humus—Vegetable earth or mould.
Hyaline—Glassy or pellucid.
Hydrated—udor, water. Containing water.
Hydrochloric acid—An acid composed of hydrogen and chlorine, formerly known as muriatic acid.
Hypersthene—Labrador hornblende. It contains iron, silica, and magnesia. It is a very tough rock, with a structure resembling gneiss.
Hypogene—upo, under, *geinomai*, I am formed. A class of rocks which have not assumed their present form and structure at the surface of the earth, but are apparently of igneous origin and thrust up from below.
Hypothesis—upo, under, *tithemi*, I place. A theory or supposition. A rational conjecture.
Icebergs—Floating masses of ice.
Ichthyosaurus—The fish lizard.
Igneous—ignis, fire. Relating or belonging to fire.
Iguanodon—From *iguana*, and *odous*, tooth. An extinct genus of gigantic herbivorous reptiles, discovered in the south of England.
Imbricata—Imbricate, tile-like. Arranged like tiles.
Imbricated—Placed like the tiles of a house, or like scales.
Imperforated—Not pierced; without an umbilicus.
Impressa—Impressed, engraven, marked.
Inequivalve—Where one valve is more convex than the other, or dissimilar in other respects.
Incandescent—Greatly heated.
Incoherent—in, not, *con*, with, *hæreo*, I adhere. Loose, wanting cohesion.
Incrustation—crusta, a crust. A covering like a crust.
Infiltration—filtrare, to filter. The act of filtering through, producing an accumulation of liquid.
Infusoria—Imperfectly developed microscopic animals inhabiting water and various liquids.
Inosculate—To unite the extremities by contact.
In place—In their original position where they were formed.
Inserted—Attached.
In situ—In original place or bed.
Intercalated—intercalo, I place between. Placed between.
Intercalation—The placing one substance between others, as one stratum between two others.
Interposed—inter, between, *pono*, I place. Placed between.
Intrusion—The act of thrusting or forcing in.
Involute—Having the exterior lip turned inwards at the margin.
Isolated—isola, an island. Separated like an island.
Isothermal—isos, equal, *therme*, heat. *Isothermal lines* are those which pass through those points on the surface of the earth, at which the mean annual temperature is the same.
Jasper—A silicious mineral of various colors.
Jointed—Having cracks, usually across the strata.
Jurassic—Belonging to the Jura Mountains.
Labra—The lips.
Labradorite—Labrador spar. It consists of silicate of alumina, lime, and soda, with traces of oxyd of iron. It is a variety of feldspar.
Labyrinthica—Labyrinth-like.
Lacustrine—lacus, a lake. Belonging or relating to lakes.
Lævis—Smooth, bare, bold.
Lamellæ—Thin plates or scales.
Lamina—plur. laminæ. A plate.
Lanceolate—Oblong, and gradually tapering like a lance.

Landslip or *landslide*—The removal of a portion of land down an inclined surface, from its attachment being lessened by the action of water beneath, or by an earthquake.
Lateralis—Lateral.
Lava—The substances which flow in a melted state from a volcano.
Lenta—Slow, heavy, stupid.
Lepidodendron—lepis, scale, *dendron*, a tree. A genus of fossil plants, having a scaly bark.
Ligneous—lignum, wood. Woody; of the nature of wood.
Lignite—lignum, wood. A kind of coal.
Linearis—Linear, line-like.
Line of bearing—Strike.
Lingula—A little tongue. Name of a genus of bivalves.
Liquefaction—The act of becoming liquid.
Lithographic—lithos, stone, *grapho*, I write. Lithographic stone, used for the purposes of lithography.
Lithological—The stony character of a mineral mass.
Littoralis—Littoral; belonging or relating to the shore.
Loam—A mixture of sand and clay.
Lodes—Veins containing metallic ores.
Loess—A German geological term, applied to a tertiary alluvial deposit, which occurs in patches between Cologne and Basle.
Longitudinal—Lengthwise. Pertaining to the length.
Lycopodiaceæ—lukos, a wolf, *pous*, foot. A natural order of plants which includes the lycopodium.
Lymnea or *limnea—limne*, a pool. A genus of fresh-water snails.
Lunated—Formed like a half moon.
Madrepore—A kind of coral.
Magnesia—A white, tasteless, earthy substance.
Magnesian—Relating to or containing magnesia.
Magnesian limestone—Limestone which contains magnesia.
Magnetic—Having properties of the magnet or loadstone.
Mammal—Any animal that suckles its young.
Mammillary—mammilla, a little nipple. Studded over with small rounded projections.
Mammillated—Studded with mammillæ or rounded protuberances.
Mammoth—An extinct species of elephant.
Marine—mare, the sea. Relating to the sea.
Marl—Argillaceous carbonate of lime. There are several varieties of marl.
Marsupial—marsupium, a pouch. Any animal having a peculiar pouch in front or on the abdomen.
Mastodon—mastos, a nipple, *odous*, tooth. A genus of extinct quadrupeds allied to the elephant.
Matrix—The stony substance in which metallic ores and crystalline minerals are imbedded. *Gangue*.
Maximum—Greatest.
Medullary rays—medulla, marrow. The vertical plates of cellular tissue which radiate from the center of the stem through the wood to the bark in exogynous plants.
Megalichthys—megas, great, *ichthus*, fish. An extinct genus of fishes, including species of great size.
Megalodon—megas, great, *odous*, tooth. A genus of peculiar fossil bivalve shells.
Megalonyx—megas, great, *onux*, a claw. A large fossil mammal.
Metalliferous—Containing metal.
Metamorphic—Relating to metamorphism.
Metamorphism—meta, indicating change, *morphe*, form. Change of condition or form.
Metamorphosis—Change of form.
Mica—mico, I shine. A mineral generally found in thin elastic laminæ, soft, smooth, and of various colors and degrees of transparency. It is one of the constituents of granite.
Micaceous—Of the nature of mica.
Microscopic—Minute; perceivable only by the aid of a microscope.
Millstone grit—Coarse-grained, quartzose sandstone.
Mine—Any subterraneous work or excavation which has for its object the extraction of any mineral products, as metallic ores, coal, &c.
Mineral—Any *inorganic* natural object, whether solid, liquid, or gaseous.
Mineralogy—That branch of natural science which treats of the properties of minerals.
Minima, } Least.
Minimum, }
Miocene—meion, less, *kainos*, recent. Middle tertiary strata.
Mollusk—mollis, soft. Any animal of the class of mollusca.
Monocotyledons—monos, single, *kotuledon*, seed-lobe. A class of plants having but one seed-lobe in the embryo.
Moraines—Longitudinal deposits of stony detritus found at the bases and along the edges of glaciers.
Multilocular—multus, many, *loculus*, a partition. Having many chambers or partitions.
Mural—murus, a wall. Belonging or relating to a wall.
Murex—A shell fish. A genus of univalve mollusks.
Muricata—Full of sharp prickles or points.
Mussel—A bivalve mollusk.
Mya—A genus of bivalve mollusks.
Nacreous—Pearly.
Nautilus—A genus of cephalopods.
Neptunian—From Neptune, god of the sea. Belonging or relating to water.

Nerinea—A genus of fossil univalves, resembling both Cerethium and Turritella.
Nidiformis—In form of a bird's nest.
Nitid—Glossy.
Nodosus—Knotty.
Nodule—*nodus*, a knot. A rounded irregular lump or mass.
Noduler—A rounded mineral mass.
Normal—*norma*, a rule. According to the peculiarities of a family or genus, without the least departure.
Nucleus—A kernel. The solid core of a body.
Nucula—*nux*, a nut. A genus of bivalve shells with numerous teeth like those of a comb.
Nummulites—*nummus*, money, *lithos*, stone. An extinct genus of cephalopods, of a thin lenticular shape, divided internally into small chambers.
Obsidian—Named after Obsidius. A glassy lava. Volcanic glass. It consists of silica and alumina, with a little potash and oxyd of iron.
Ocellated—Applied to eye-like spots.
Oolite—*oon*, an egg, *lithos*, stone. A granular variety of carbonate of lime, frequently called *roestone*.
Oolitic—Belonging or relating to oolite.
Opalescent—Resembling opal, a beautiful mineral, characterized by its iridescent reflection of light.
Operculum—*operio*, I cover. The lid which protects the gills of fishes, and closes the opening of certain univalve shells.
Orbicular—Spherical, circular.
Ores—Mineral bodies from which metals are extracted.
Organic—Relating to organs.
Organized—Possessing organs.
Organization—A mode of structure.
Orthis—A genus of fossil bivalve shells.
Orthoceratite—*orthos*, straight, *keras*, horn. A straight or slightly bent, cylindrical many chambered shell, with septa concave toward the larger end.
Outcrop—The emergence of a rock, in place, at the surface.
Outlier—A hill or range of strata occurring at some distance from the general mass or formation to which it belongs.
Ovatus—Ovate, egg-shaped.
Overlying—When one stratum lies over or overlaps another it is said to be overlying.
Oxyd—The combination of oxygen with any metallic base.
Oxygen—*oxus*, acid, *gennein*, to generate. Vital air.
Pachyderma—*pachus*, thick, *derma*, skin. Thick-skinned.
Palæontologist—One skilled in palæontology.
Palæontology—*palaios*, ancient, *on*, creature, *logos*, a discourse. That branch of zoological science which treats of fossil organic remains.
Palæozoic—*palaios*, ancient, *zoe*, life. Relating to ancient life.
Palmacites—A genus of fossil plants.
Palmated—Webbed, as in the feet of some water birds.
Paludina—*palus*, a marsh. A genus of fresh water gasteropods.
Popillary, *Popillous*, } Having the surface covered with dots or pimples.
Parasite—An adherent, a hanger on.
Parasitical—Living on some other body or animal.
Parietes—*paries*, a wall. The sides or parts forming an inclosure.
Patulous—With a gap or opening.
Peduncle—A foot-stalk or tube on which anything is seated.
Pecopteris—*pekos*, sheep-skin, *pteris*, a fern. A genus of fossil ferns.
Pecten—A comb. A genus of bivalve mollusks.
Pelagic—Belonging to the deep sea.
Peltate—Shield-shaped, orbicular, and attached by a central pedicle.
Pentagonal—Having five angles.
Percolate—*per*, through, *colo*, I strain. To strain or drip through.
Peridot—Prismatic chrysolite.
Perlite—Pearlstone, a gray variety of obsidian.
Peroxyd—The highest degree of oxydizement of which a metal or other substance is susceptible without becoming an acid.
Petroleum—Stone oil. Mineral oil.
Phenomenon—Appearance, visible quality, event.
Phonolite—Clinkstone, a species of compact basalt, which is sonorous when struck.
Pillar—In univalves is the internal continuation of the columella or inner lips, and extends from the base to the apex.
Pinnated—Winged.
Plaster of Paris—A substance prepared by heating gypsum.
Plateau—An elevated plane or table land.
Platina or *platinum*—*plata*, silver, on account of its color. A metal of a whitish color, exceedingly ductile, malleable, and of difficult fusion.
Pliocene—*pleion*, more, *kainos*, recent. The newest or most recent tertiary strata.
Plumose—Having a feathery appearance.
Plutonic—After Pluto, the god of fire. Relating to fire.
Polyp—*polus*, many, *pous*, foot. A radiated animal which has a cylindrical or oval body or sac, with an opening at one extremity, around which are long feelers.
Polyparia and *polypiaria*—Groups of polyps or animalcules which form coral.

Porous—Containing pores.
Porphyritic—Of the nature of porphyry.
Porphyry—*porphura*, purple. Originally applied to a *red* rock found in Egypt. A compact feldspathic rock containing disseminated crystals of feldspar, the latter, when polished, forming small angular spots, of a light color, thickly sprinkled over the surface.
Pozzuolana and *pouzzuolani*—Volcanic ashes used in the manufacture of mortar which hardens under water: Exported from Pozzuoli, near Naples.
Precipitation—The act by which a body abandons a liquid in which it is dissolved or suspended, and becomes deposited at the bottom.
Produced—Lengthened out.
Pudding stone—Conglomerate.
Pumice—Vesicular obsidian.
Pyriform—Pear-shaped.
Pyrites—A compound of sulphur and iron.
Pyroxene—Augite.
Quadrangular—Having four right angles.
Quaquaversal—Turning each way.
Quarry—A stone mine; a place where stones are dug.
Quartz—Rock crystal. A constituent of granite and some other rocks.
Quartzose—Of the nature of quartz.
Radiata—Radiate. The name of a class of zoophytes.
Radiate—*radius*, a ray. Furnished with rays.
Radiation—The emission of rays of light, or of heat, from a luminous or a heated body.
Ramose—Branched.
Realgar—Red sulphuret of arsenic. A compound of sulphur and arsenic.
Rectangular—Having right angles.
Reflected—Thrown backwards or bent back.
Refrigeration—The act of cooling.
Reniform—Kidney-shaped.
Repand—With a waved margin.
Resinous—Containing resin.
Resupinate—Lying upon the back.
Reticulated—Formed like net work.
Reversed spire—Is when the volutions of a shell turn the reverse way of a common screw.
Riving seams—Open fissures between beds of rock in a quarry.
Rock—Any mineral aggregate.
Rodentia—*rodere*, to gnaw. An order of mammals.
Rodents—Gnawers; animals of the order of rodentia.
Rotund—Rounded; circular.
Rubble—Angular and broken fragments of subjacent rock lying beneath the superficial mould.
Rufous—Of a reddish color.
Rugosa—Rugose; wrinkled.
Rugosity—A wrinkling.
Saccharoid—*saccharum*, sugar, and *eidos*, resemblance. Resembling loaf-sugar.
Salt—Any combination of an acid with a salifiable substance.
Sandstone—Any rock consisting of aggregated grains of sand.
Saurians—*sauros*, a lizard. Animals of the lizard tribe.
Sauroid—*sauros*, a lizard, *eidos*, resemblance. Resembling a lizard.
Scabra—Rough.
Scabrous—*scabra*, rough. Rough or harsh, like a file.
Schist—*schistos*, split. Slaty rock.
Schistose—Slaty.
Scoriaceous—Of the nature of scoriæ.
Scutellated, *Scutelliform*, } *scutum*, a buckler. Shaped like a shield.
Seams—Thin layers or strata interposed between others.
Sediment—*sedeo*, I sit. That which subsides or settles to the bottom of any liquid; dregs.
Sedimentary—Belonging or relating to sediment.
Selenite—A variety of gypsum.
Semicrystalline—Partly crystalline.
Sensibly—Perceptibly.
Sepia—A kind of paint or ink prepared from the cuttle-fish.
Septaria—Flattened balls of stone, which have been more or less cracked in different directions, and cemented together by mineral matter which fills the fissures.
Septiform—Having the shape of a partition.
Septum—A partition.
Serpentine—A magnesian rock of various colors, and often speckled like a serpent's back.
Serrated—*serra*, a saw. Like the teeth of a saw.
Sessile—*sessilis*, dwarfish. Without a pedicle or support.
Setose—Covered with bristles.
Shale—An indurated slaty clay, or clay-slate.
Shingle—Loose, water-worn gravel and pebbles.
Sigillaria—*sigillum*, a seal. Fossil plants found in the coal formation.
Silex—*chalis*, a pebble. The principal constituent of quartz, rock-crystal, flint, and other silicious minerals.
Silica—Silicious earth; the oxyd of silicon (the elementary basis of silica), constituting almost the whole of silex or flint.
Silicious—Containing silica.
Silicified—Petrified or mineralized by silicious earth.
Silurian system—Series of rocks formerly known as the greywacke series.
Sinister valve—The left valve.
Sinus—A hollow or excavation.
Sinuosity—A hollow; an irregular, winding excavation or hollow.
Siphon—*siphon*, a tube. A cylindrical canal, perforating the partitions of multilocular shells.

Siphuncle—A cylindrical canal, perforating the partitions of chambered shells.
Slate—A well known rock, which is divisible into thin plates or layers.
Solfatara—A volcanic vent emitting sulphur and sulphurous compounds.
Species—The division of a genus into those derived from one common parentage.
Spinosa, *Spinosum*, } Spinous; covered with spines.
Spire—All the whorls of univalve shells, except the one in which the aperture occurs, which is called the *body*.
Squamose—Scaly.
Stalactites—*stalasso*, I drop. Conical concretions of carbonate of lime attached to the roofs of calcareous caverns, and formed by the gradual dropping of water holding the carbonate in solution.
Stalagmites—Stalactical formations of carbonate of lime, found on the floors of calcareous caverns.
Staurotide—*stauros*, a cross, *eidos*, form. Cross-stone; prismatic garnet.
Stigmaria—*stigma*, an impression. A vegetable fossil found in coal formation.
Strata—Plur. of stratum.
Stratum—A layer; a bed.
Stratification—An arrangement in beds or layers.
Stratified—Arranged in strata.
Striæ—Diminutive channels or creases.
Striated—Marked with striæ, or scratches.
Strike—The direction of strata; the line of bearing.
Sub—Under. In connection with other words means almost, or approaching to; as subconic, somewhat conical.
Sublimation—The process by which volatile substances are raised by heat, and again condensed into the solid form.
Subulate—Awl-shaped.
Submarine—Beneath the sea.
Submerged—Immersed or covered by water.
Subplicata—Somewhat plaited.
Subsidence—Sinking or falling.
Substratum—An under-layer or bed.
Sulcata, *Sulcatus*, } Sulcate; grooved or furrowed.
Sulphuret—A compound of sulphur with another solid.
Sulphuric, *Sulphurous*, } Relating to sulphur. Applied to acids composed of sulphur and oxygen.
Superposed—*super*, above, *pono*, I place. Placed above.
Suture—The hollow line of division in univalve shells, between the whorls.
Syenite—A granitic rock from Syene or Siena, in Egypt. It consists of quartz, feldspar, and hornblende.
Synclinal—*sun*, with, *klinein*, to incline. A synclinal axis is a line *towards* which strata slope downwards on each side like the letter V.
Tabular—In form of a table; horizontal.
Talc—A foliated magnesian mineral of an unctuous feel, often used for tracing lines on wood, cloth, &c., which are not so easily effaced as those of chalk.
Talcose—Of the nature of talc.
Talus—A sloping heap of fragments accumulated at the foot of a steep rock.
Terebellum—*terebro*, I bore. A genus of gasteropod mollusks.
Terete—Cylindrical and tapering.
Terminal—Belonging to the end.
Testaceous—*testa*, a shell. Consisting of carbonate of lime and animal matter.
Testudinaria—A tribe of chelonian reptiles.
Thermal—*therme*, heat. Warm; hot.
Thin out—Strata are said to thin out when they diminish in thickness.
Trachyte—*trachus*, rough. A variety of lava; a feldspathic rock, which often contains glassy feldspar and hornblende.
Transverse—Placed cross-wise. When the breadth of a shell is greater than its length it is called transverse.
Trap—*trappa*, a flight of stairs. Certain igneous rocks, composed of feldspar, augite, and hornblende.
Trappean—Relating to trap rocks.
Travertin—*travertino*. Limestone deposited from water holding carbonate of lime in solution.
Tremolite—A mineral, often of a fibrous structure, generally containing silica, magnesia, and carbonate of lime, originally found in the valley of Tremola, on St. Gothard.
Trenchant—Cutting.
Trias—*tres*, three. The Trias or Triassic formation is between the Permian and Lias; the upper New Red Sandstone.
Triassic—Of the nature of trias.
Trigonal—Having three angles.
Trigonia—*trigonos*, three-cornered. A genus of bivalve mollusks, most of which are extinct.
Trigonula—Having three little angles.
Trilobite—A crustacean having three lobes.
Trituration—*tritus*, rubbed. The act of rubbing or grinding.
Truncate—Terminating very abruptly, as if a portion had been cut off.
Truncated—Cut short or abruptly off the end or top.
Tumid—Swollen or distended.
Tunicated—Coated.
Turbinate, *Turbinated*, } Shaped like a top or pear.
Turbo—A twisting. A genus of univalve gasteropods.
Turbinata, *Turbinatum*, } Shaped like a top.
Turgid—Swollen.

Turriculated—Resembling a tower with turrets.
Turritella—A little tower or turret. A genus of gasteropods.
Umbilicated—Having a depression in the center like a navel.
Umbo—In bivalve shells, that part near the hinge immediately under the beak.
Unconformable stratification—Where the strata are not parallel.
Undulation—A wave; arranged in a wave-like manner.
Undulatus—Waved; having a waved surface.
Unilocular—*unus*, one, *loculus*, partition. Having but one chamber or compartment.
Unio—A pearl. A genus of mussels.
Univalve—Shells consisting of but one valve or piece.
Unstratified—Not stratified.
Uptilted—Tilted up; raised at one end.
Valve—A distinct piece or part of a shell.
Vascular—Containing numerous vessels.
Vaulted—Arched.
Veins—Fissures in rocks filled by mineral substance.
Venericardia—*Venus* and *cardium*. A genus of bivalve mollusks.
Ventral—Belonging to the belly.
Ventricosa—Ventricose; inflated, swelled in the middle.
Vermiform—Worm-shaped.
Vertebra—*vertere*, to turn. A joint or bone of the spine.
Vertebræ—Plur. of vertebra.
Vertebral column—The spine or back-bone.
Vertebrate—Having vertebræ, or a spine.
Vesicularis—Vesicular; containing vesicles.
Vitreous—*vitrea*, glass. Resembling glass.
Vitreo-resinous—Partaking of the nature of glass and resin.
Volatile—*volo*, I fly. Capable of assuming the state of vapor, and flying off.
Volcanic—Relating to a volcano.
Voluta—A whorl. A genus of gasteropods.
Volutions—The whorls or turnings of the shells of univalves.
Vulgaris—Common.
Whorl—One of the wreaths or turnings of the spire of univalves.
Zigzag—Having contrary turnings and windings.
Zones—Belts or bands.
Zoophyte—*zoon*, an animal, *phuton*, plant. A plant-animal, which seemingly partakes of the properties of both plants and animals.

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