Town Clerk
of
Alexandria.
Moorestown.

FIRST

ANNUAL REPORT

ON THE

GEOLOGY OF VERMONT.

1845.

To His Excellency

WILLIAM SLADE, *Governor of Vermont:*

SIR,

I herewith submit the first report on the Geology of Vermont,

and have the honor to remain,

Your Excellency's obedient servant,

C. B. ADAMS, *State Geologist.*

Middlebury, Oct. 1, 1845.

INTRODUCTION.

The importance of developing the sources of mineral wealth has long been appreciated in civilized countries. The superior efficiency of systematic and intelligent effort, in operations which require a knowledge of the structure of the earth, of the situations in which minerals may be found, of their modes of occurrence, and of their chemical constitution and properties, naturally led to the establishment by governments in Europe, of those schools of mineralogy, which are almost coëval with the science itself. The benefits of such establishments not accruing to a few individuals only, but being diffused widely, it was the obvious duty of those governments, rather than the interest of individuals, to promote the knowledge of this science.

Other modes of educing and diffusing the economical advantages of geology and mineralogy have been practiced with success, and none more so, than the surveys, which have been executed under legislative authority in most of the states of our Union.

The honor of the first movement in this work belongs to North Carolina, whose legislature, in 1823, commissioned Professor Olmsted to make a geological survey of that state. In the following year, South Carolina gave a similar commission to Professor Vanuxem. The example of these states, however, seemed likely to be forgotten, when, in 1830, the legislature of Massachusetts made provision for a survey, which was executed by Professor (now President) Hitchcock, with such distinguished success, that the example has since been followed by nearly all the states in the Union.

The subject was first brought before the legislature of this state in 1836, and has been discussed at most of the subsequent sessions. While other states have had the honor of being foremost, we enjoy the more substantial advantage of carrying on the work with the aid of their experience, at a period when much progress has been made in developing the leading features of American Geology.

Vermont, unlike the neighboring states, being deprived by nature of foreign commerce, must look within herself for the sources of wealth. Already has the enterprise of individuals developed mineral treasures, which have, while enriching their possessors, conferred prosperity on several of our villages.

Marble, iron, and manganese have richly rewarded skill and enterprise, while most of our mineral wealth yet lies concealed beneath the surface, to be revealed, not by any mysterious and unintelligible arts, but by simple methods, which are the result of practical knowledge, and which commend themselves to the common sense of every man. Without this practical knowledge, some ore-beds and quarries may be discovered by random explorations. But most of our valuable minerals extend through the state in narrow strips from north to south. Now by a systematic survey of those rocks, in which *only* these minerals are to be found in valuable quantities, their situation in the several towns may be ascertained. This could not be done to advantage by many persons, each in a small district, ignorant of the labors of others. But one person, or several under one head, traversing every part of the state, will be able to exhibit on a map the situation of each kind of rock, and, with the help of samples and descriptions, will put into the power of any one to know where to look for such minerals. Actual discoveries, therefore, important as they may be, constitute but a small part of the benefits of a geological survey; for a survey, well executed, will raise up numerous discoverers for future years.

One important object of a survey should be to obtain and communicate information of the modes of working ore-beds, of quarrying, and of manufacturing the materials, and to bring to notice valuable minerals, which are unknown or neglected. Thus, for example, we have excellent materials for the manufacture of fine porcelain, in quantities probably inexhaustible.

The agricultural interest sustains very important relations to the geological survey. All the mineral particles of soils originated from the decay of the solid rocks; and although powerful agents—such as currents of water with immense masses of ice sweeping southward over the northern portions of the globe—have more or less mingled the materials of the soils of different regions, there is generally an important connection between the soil and the foundation rock of any district. The first step, then, towards a knowledge of the soils will have been taken, when the different kinds of rocks shall have been exhibited on a map of the state. The degree of fineness of soils, their power of absorbing heat and moisture, the quantity of organic matter present, and of the fertilizing salts, should also receive attention. The communication of knowledge on these subjects in their relations to practical agriculture may also be an important object in the Final Report.

It is also an object to examine, as far as practicable, the simple minerals existing in the state, and to describe them in a systematic but popular manner, so that a knowledge of our minerals may be within the reach of all our citizens.

The scientific geology of the state is, of course, a leading object, both on account of its intrinsic importance, and because it is the only safe basis for the economical department.

During the past season, the leading object, especially of my personal labors in the field, has been to ascertain the character and limits of the geological formations, with their most useful mineral contents,—the foundation of all the other objects of the survey; and thus to ascertain what portions of the state most abound in mineral wealth, and may be regarded as mineral regions. Subordinate objects have been to examine places supposed, with more or less reason, to contain valuable minerals, and advise to, or dissuade from, farther exploration; and to communicate information on the subjects of geology and mineralogy on all suitable occasions in public and private. Two of my assistants, operating as a detached party, have, while attending to the same objects, made a more minute examination of the districts assigned to them.

In accomplishing these objects, I have been assisted in the field labor by Rev. Zadock Thompson and Rev. S. R. Hall, whose energy and perseverance, during four months of severe labor, have been alike highly creditable to them and useful to the survey. The duties of assistant in the depot of specimens and of occasional service in the field have been faithfully performed by Dr. S. P. Lathrop. Messrs. L. F. Locke and Edward Hitchcock, jr. have also performed occasional service as assistants in field labor.

Probably few, if any, surveys have met with such hearty and efficient coöperation from the people as we have received. We have not merely been assisted by many in all parts of the state, who have devoted their time to aid in our objects, but the very deep and general interest manifested in these objects, and strong expressions of good will, have been of the most cheering character. Unable to enumerate the many to whom acknowledgments are due, we are restricted to this general expression of our thanks for the aid and encouragement so freely bestowed.

Your Excellency having directed me to procure one suite of specimens for a state collection, and one for each of the three literary and two medical colleges, and one for the Troy Conference Academy at Poultney, I have collected about 6000 specimens of rocks, minerals, and fossils, and placed them in a geological depot at Middlebury.

A well digested report of the results, requiring much examination of specimens and many analyses, would need at least as much time as has been given to the field labors. Accordingly I have selected those facts, which are of economical interest, for this report, which is hastily prepared during the last few days of the season.

The coming winter will be devoted to the arrangement of the facts collected during the summer, and the preparation of materials to be used in writing the final Report; and to the examination and analysis of specimens. The analyses will be performed in the well furnished laboratory of Yale College, for which the assistance of Denison Olmsted, jr., of New Haven, eminently qualified for that service, has been engaged.

During the ensuing year, the plan of the survey contemplates the following principal objects:—the collection and analysis of soils; the collection and examination of the simple minerals, both those of economical and of scientific importance; and farther investigations into the character and limits of the Geological formations. In order to execute this plan most efficiently, it would be very desirable, if the appropriation would admit, to add to the force already employed, an assistant, who should devote special attention to the collection of minerals, and also to chemical analyses, to which last object, my general duties as State Geologist render it difficult for me to devote the requisite attention. A moderate additional appropriation would secure these objects. The analysis of soils, to be of much value, should be numerous, and made with great care. Probably few are aware of the great labor and expense of such analyses.

The estimates of the expenses for the ensuing year, with an account of the expenses of the current year, will be found in the appendix to this report.

In order to render available, in the early stages of the survey, those facts which are of economical importance, it has been deemed expedient to describe them, as far as the progress made, and the time allowed for the preparation of this report, will permit. To many of our citizens, who have not had access to the reports made of other geological surveys, such a report will also be useful, as a practical exhibition of some of the objects and results contemplated in the survey; and to our citizens generally, it is hoped, that this small beginning, in an attempt to make known the mineral wealth of the state, will not be without interest.

Since, however, the application of geology to economical purposes cannot be understood without some knowledge of geology itself, a few preliminary remarks on the elements of the science are here offered. Of the technical terms, which are unavoidably introduced into this report, some will be explained in these remarks, and the rest may be found in a glossary which is appended.

PRELIMINARY CONSIDERATIONS.

Simple Minerals.

NATURE is often compared to a volume, written by the hand of Infinite Wisdom and Power, and spread open for our perusal. If there be justice in this comparison, we may anticipate in the study of such a work both profit and pleasure. In Geology, the comparison is peculiarly appropriate: for as a book is composed of letters of the alphabet, grouped into words and sentences, so is the crust of the earth composed of many distinct kinds of minerals, which, being mixed together, constitute rocks; and many of the rocks, occurring in groups of strata, with certain distinctive marks, forming a separate chapter in the history of the globe, constitute what are called formations.

Minerals, then, are the alphabet of Geology. When they occur in homogeneous masses, they are called simple minerals; and when two or more simple minerals have been mixed together, they form a rock. In a few cases, a simple mineral, as limestone, or serpentine, is also called a rock, because it occurs in extensive ledges.

There are, in the crust of the earth, 434 kinds of simple minerals; and if a knowledge of all were an indispensable preparation for the study of Geology, most of those into whose hands this report may come might well be discouraged. But *five* only of these minerals constitute about nine-tenths of the crust of the earth, and with the addition of two or three more the number will embrace nineteen-twentieths.

Quartz is the most abundant of all minerals, constituting nearly one half of the crust of the earth. It is one of the harder minerals, scratching glass with facility, although inferior to the diamond. When regularly crystallized, it is called rock crystal, and is more or less transparent. Its numerous varieties occur with all colors. Arenaceous quartz is a variety, which is more or less easily crumbled into grains, and is therefore of great use in the manufacture of glass, of which it is the principal constituent. Flint is a variety, with an impalpable structure and con-

choidal fracture. The presence of small portions of iron, manganese, chrome, and other foreign substances, produces numeraus varieties, some of which are valued as gems, such as jasper, amethyst, agates, cornelian, &c. The sand, which is used in making mortar, is mostly quartz.

Feldspar constitutes about one-tenth of the crust of the earth. It is less glassy in its appearance than quartz, and is not quite so hard. It has a pearly lustre, and is more frequently of a greyish white color, although sometimes red, green, &c. When decomposed, it forms an unctuous white clay, called kaolin, which is of great use in the manufacture of fine bricks, stone ware, pottery and porcelain. The undecomposed mineral, pulverized, is used with kaolin in the manufacture of the finest porcelain. Common clay is impure decomposed feldspar. It usually contains a small portion of the protoxide of iron, which by heat is converted into the peroxide of iron, a red substance, which gives the color to common bricks and pottery.

Limestone (carbonate of lime) forms about one-seventh of the crust of the earth. Its varieties are numerous; those which are crystallized are called calcareous spar. It is much softer than quartz or feldspar, being easily scratched. Varieties, which admit of a fine polish, are called marble. At a red heat the carbonic acid gas is expelled, and the stone becomes lime. Marl is a pulverulent variety, more or less mixed with particles of clay, and is of great use in agriculture. Calcareous tufa is a deposit of this mineral from mineral springs. Carbonate of lime is easily distinguished from other common minerals, by the application of a drop of acid, which will produce effervescence.

Hornblende, including *augite*, which is now regarded as merely a variety of hornblende, constitutes a large part of the rocks of volcanic origin, and some of the older slates. It forms from one-fifteenth to one-twentieth part of the crust of the earth. Some of its varieties are beautiful minerals, as actinolite, amianthus, &c. prized by the mineralogist, but of little economical value. Asbestus is a remarkable variety, consisting of excessively slender silky fibres, which may be picked and wove like cotton into cloth, which will be incombustible. It may also be used for incombustible lamp-wicks. Compact rocks, of which this mineral forms any considerable portion, although not hard as quartz rocks, are exceedingly tough.

Mica, often improperly called isinglass, is about equally abundant with the preceding. It is not very hard, and usually occurs in thin elastic plates, which are sometimes found containing one or two square feet, but more frequently are very small, like scales, shining, black, brown, or silver-colored. The large sheets are used for lanterns, stove-windows, and in the Russian navy

for common windows, not being broken by the concussion of a broadside.

Talc, is one of the softest minerals, being very easily cut with a knife. It often resembles mica, but is softer, not elastic, and has an unctuous feel. It contains 30 to 33 per cent. of magnesia. One of its varieties, steatite (soapstone) occurs in extensive beds, and is much used for fire places, stove-linings, &c. Talc is usually light green.

Chlorite, usually dark green, differs but little from talc. It also contains about 30 per cent. of magnesia.

Serpentine, is usually of some shade of green, the lighter varieties being called precious serpentine. It is harder than limestone. It receives a high polish, and when free from the cracks and seams, with which it usually abounds, is an elegant substitute for marble.

Gypsum (plaster), *rock salt*, and *coal*, are the only other minerals which form any considerable portion of the earth's crust.

Structure of the Earth.

A few explanations respecting the general structure of the earth are here necessary. By the *crust of the earth* we mean so much as comes within the reach of observation and legitimate inference, which is much more than is commonly supposed by those who are unacquainted with Geology. The crust is composed essentially of solid rocks—the loam, sand, gravel, clay, and other soft or loose materials, being merely a superficial covering.

There are two kinds of rocks, differing both in structure and origin—the *stratified* and the *unstratified*.

The stratified rocks occur in layers or strata, and were deposited from water. Hence those which lie beneath are most ancient; and where two kinds of stratified rocks occur in junction, the one lying under the other, their relative age is obvious. By this simple principle of position, the relative age of most of the rocks has been determined. The various circumstances attending the deposition may also, to a great extent, be inferred from the character of the strata. Thin layers, of fine materials, and of very uniform thickness, are deposited from quiet water, and those which consist of coarse gravel and pebbles, are the products of agitated waters. The layers of the stratified rocks, originally mud, sand, gravel, shells, coral, &c., have since become solid by the agency of heat, pressure, cohesion, crystallization, &c.

The unstratified rocks, on the other hand, usually occur in irregular masses, sometimes overlaying other rocks, in veins cutting across the layers of stratified rocks, or forming beds interposed between those strata. Modern lavas and ancient granites

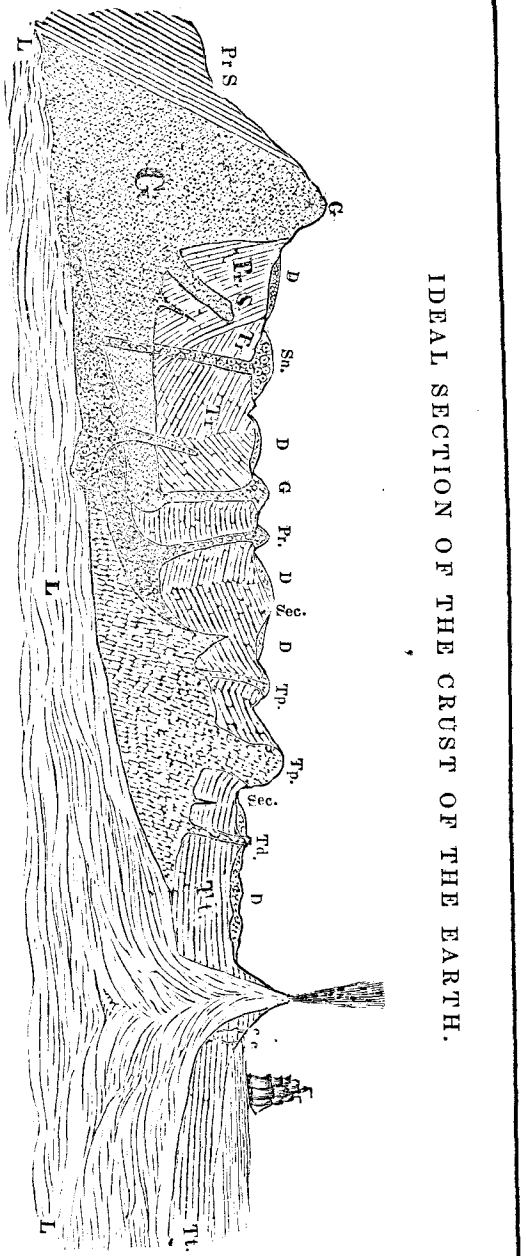
are alike unstratified and of igneous origin—the various unstratified rocks having been erupted, as lava, at different periods in the history of the earth.

The unstratified rocks, which are now erupted from volcanoes, have their source beneath all other known rocks; and it is inferred from various data, that those of ancient date were in like manner erupted from beneath the then existing rocks. Going far back in the geological history of the globe, we come to a period when the lowest and oldest stratified rock rested alone upon granite, the oldest of the unstratified. Beneath are doubtless, in immense irregular beds, the reservoirs, whence the eruptions of the igneous rocks had their origin, and above we have the successive strata, whose contents reveal the physical history of the earth.

The convulsions of ancient times, which many Geologists believe to have been far more violent than those which have occurred during the period of human history, have more or less broken and tilted up the layers of the stratified rocks, so that few of them now lie in their original horizontal position. They are more or less inclined, and are often nearly or quite perpendicular. It is obvious that in such cases, when we pass over the surface of the ground at right angles to the direction of the strata, we cross the edges or thickness of the rock, and that we thus gain the same knowledge of their structure, which we should have obtained by a perpendicular descent, had the strata retained their original horizontal position. If, for instance, we travel 40 miles over strata, which have a *dip* (as the inclination below the horizon is technically called) of 45 deg., the thickness of the strata exceeds 26 miles. It is unnecessary, therefore, for the geologist to descend into the bowels of the earth to ascertain its structure. A view of the surface of the solid rocks, as exposed in precipices, on sea-coasts, by rivers, rail-road cuttings, and by other natural and artificial agencies, and the eruptions of volcanoes, have made us acquainted with the structure of the earth to a depth a hundred fold greater than human agency has reached.

A general idea of the structure of the earth may be obtained from the following figure, which is not intended to represent any given region, but is a general exhibition of the positions of the rocks, as they would appear in a section through the crust of the earth. A little attention to the explanations will supersede the necessity of a lengthened description.

IDEAL SECTION OF THE CRUST OF THE EARTH.



Explanations.—Unstratified rocks, of igneous origin:— G, granite; Sn, seinite; Pr, porphyry; Tp, trap rocks; Td, a trap dyke; L, lava, with a volcano; *c c* being fissures through which the water of the ocean penetrates to the melted lava, by its conversion into steam, causing earthquakes and eruptions.

Stratified rocks, (represented by parallel lines), of aqueous origin:—Pr, S, primary strata; Tr, palæozoic rocks, or the oldest rocks which contain the remains of animals, and plants; Sec, secondary rocks; Tt, tertiary strata; D, the superficial covering of sand, gravel, and loose stones, called "drift."

The *unstratified* or igneous *rocks* cannot be classified chronologically with the same precision as the stratified rocks. Their age is estimated by the strata, through which they have penetrated, the igneous rock being obviously more recent than such strata. But it is not to be inferred, in every case, that the overlying strata are more recent than the igneous rock, since the eruptive force of the latter may not have been sufficient to penetrate all the strata. In numerous cases where the strata have been broken through, and no strata have been subsequently deposited over the igneous rock, it is very difficult to determine how much more recent is the igneous than the stratified rock. Their mineral characters are also employed in their classification.

These rocks occur in *beds* interposed between the layers of stratified rocks; in *dykes* or *veins*, filling fissures, which cut through both stratified and unstratified rocks; as *overlying masses*, which have been erupted and flowed over the adjacent rocks; and as *irregular masses* beneath the stratified rocks.

Granite is composed of quartz, feldspar, and mica. When hornblende takes the place of mica, the rock is called *sienite*. In some cases the structure is very fine, in others the semicrystalline grains are several inches in diameter. Wherever the older stratified rocks have been penetrated to the bottom, granite has been found beneath them; whence it is inferred that this rock is, in such cases, the most ancient of all rocks, and that it formed the solid pavement of the earth's surface at an inconceivably remote period of time. Subsequently, granite has been erupted through the older stratified rocks, more rarely through the secondary strata, and the eruptions have, so far as known, long since ceased.

Next came the eruptions of *porphyry*, most frequent in the secondary periods. This rock is composed of a base of compact feldspar, containing disseminated crystals of the same mineral. It is a highly ornamental stone when polished, but the process is very expensive on account of the hardness of the rock. Any other rock, which contains disseminated crystals of feldspar, is said to be *porphyritic*.

Next, during the latter half of the secondary and during the tertiary periods, were the eruptions of the Trap rocks, so called from *trappa*, Swedish for stair, because frequently found in prismatic jointed columns, as at the celebrated Giant's Causeway in Ireland. These rocks are composed of feldspar and hornblende, and are usually of a very finely granular structure. The hornblende renders them very tough. The more ancient of these rocks are called *greenstone*, comprising those, for the most part, which were erupted during the secondary periods, and those, which have been erupted subsequently, are called *basalt*. Many of them so strongly resemble modern lavas, as to be distinguished from them with difficulty.

Lastly come *lavas*, the products of volcanoes, which are either *extinct*, that is, have not erupted within the period of human history, or are *active*, either constantly, or, for the most part, with longer or shorter intervals of repose.

The stratified rocks are divided into six classes.

1. The oldest, the *primary** *strata*, are highly crystalline in their structure, and are destitute of fossils. It is commonly supposed that no animals or plants existed during the period of their deposition, and that they have been subjected to the action of intense heat, which has greatly altered their original structure.

2. The next in order are the *palaeozoic rocks*, (in the early writers on Geology *transition* rocks), which contain the remains of the first animals and plants, which are known to have existed, and of which the species became entirely extinct at an early period of the Geological history.

3. The third class, *secondary rocks*, are less ancient; but all the species of the immense numbers of animals and plants, whose remains are entombed in these rocks, have long since become extinct.

4. The fourth class, *tertiary strata*, consist of more regular, and nearly horizontal strata of limestone, sand, and clay; and, with many extinct species of animals and plants, contain many which still exist.

5. The fifth, called *drift*, consists of those irregular, scarcely stratified masses of sand, pebbles, bowlders, hard-pan, &c., which cover most of the surface of the earth north of 35° north latitude.

6. The sixth, *alluvium*, comprises those deposits which have been accumulating since the existence of man and the present races of animated nature.

An acquaintance with the agencies now in operation, both igneous and aqueous, is essential to a correct apprehension of the causes of the phenomena of the ancient stratified and unstratified rocks.

* In the course of my Geological rambles over the State, I have heard the words 'primary' and 'secondary' used; the former as designating rocks and minerals which have not originated from any other, and the latter designating those which have thus originated. In this sense, the Geologist knows of no 'primary' rocks. Geology takes us back to a far distant era in the history of the earth, since which *all* the rocks known to us have been derived from pre-existing materials.

ECONOMICAL GEOLOGY.

Economical Geology is geology considered with reference to our physical wants, and consequently as a source of pecuniary profit. With many, the science is esteemed either exclusively or mainly on this account. We shall not attempt to disturb such in their opinions, since, while valuing it far more as a source of refined and exalted intellectual enjoyment, and as presenting to view the operations of Divine Wisdom on a scale of vast magnitude and of inconceivable duration of time,—we do, equally with any others, value it as an auxiliary to industry and enterprize.

Geological position of useful minerals.—The following general propositions lie at the foundation of all practical applications of geology, having reference to the question first in order, whether certain minerals can be found in a given district. Many of the most useful minerals are found, in quantity, only in some limited portion of the series of rocks before described. Thus coal occurs, in workable beds, only in the older secondary strata, and gypsum and salt are never found in the primary rocks. A few, as brown iron ore, occur in most of the rocks. Others, as limestone, constitute the whole, or important portions, of rock formations.

Modes of occurrence.—Another inquiry relates to the mode of their occurrence, and is therefore of the utmost practical importance. Some minerals occur in beds, or layers more or less regularly interstratified with the layers of the stratified rocks. Some occur in veins, which cut across the rocks, without reference to the stratification. Sometimes they occur in irregular masses; and in other cases they are merely disseminated in small grains through the principal rock or mineral. Regular beds and veins are most valuable, since they are much less likely to be exhausted, and often, approximate estimates may be made of their contents. Irregular masses may be trusted only for what they show, and disseminated minerals are not to be considered workable, unless in the case of the great value of the substances.

Tracing fragments to their original veins or beds.—Geology teaches us, that by some powerful agency, probably by currents of water and the drifting of icebergs, the loose materials on the surface of the earth, in northern latitudes above 35° or 36°, have been moved to the south, or a few degrees east of south, from

their previous situation. A practical inference is, that detached fragments of valuable minerals may sometimes be traced to their source in a direction north or a little west of north.

If the fragments are very large or numerous and angular, we may infer that they have not travelled far from their source. But if they are few, small, and more or less rounded, as if by much attrition, their origin is more probably many miles distant, and less likely to be discovered. Some years since a large mass of magnetic iron ore was found in Lowell, when Rev. S. R. Hall suggested the above principle, and the result was the discovery of the Troy ore.

METALS.

With the exception of iron, the metals are found chiefly in the primary, palæozoic, and older secondary rocks. In Europe, gneiss and mica slate are their principal repositories. These rocks constitute the greater part of Vermont, but in this country gneiss appears to be quite destitute of metallic ores.

ORES OF IRON.

Brown iron ore, of which *brown hematite, bog ore,* and *yellow ochre,* are merely varieties, occurs in a variety of geological situations. Bog ore occurs most frequently in wet grounds, and is now in the process of formation at the expense of other ores. Brown hematite is found both in the primary and secondary rocks, and yellow ochre generally occurs with it, resulting from its disintegration.

This ore is usually brown, with a dull earthy appearance, and is not very heavy. It may be distinguished by its streak, (the powder obtained by a file,) which is always of a yellowish brown color, and is identical with yellow ochre. Brown iron ore is composed of peroxide of iron and water, with some impurities. Absolutely pure ore contains fifty-nine per cent. of metallic iron. The presence of foreign ingredients, with the loss in the process of reduction, renders the actual product less. Iron made from this ore is easily converted into steel, and is more suitable for castings than for purposes requiring toughness.

This ore is found abundantly along the western base of the Green Mountains, usually near the eastern margin of the limestone districts, beneath the gravel or hard pan associated with yellow and red clayey ochres and porcelain clay, and overlying a brownish yellow ferruginous limestone.

Brown iron ore has been found in the following towns: Bennington, Manchester, Dorset, Tinmouth, Wallingford, Rutland,

Pittsford, Chittenden, Brandon, Leicester, Salisbury, Bristol, Monkton, Huntington, Colchester, Milton, Highgate, Swanton, Strafford, Sherburne, Plymouth, Putney, and Guilford. In small quantities, especially as an ochrey sediment, this ore is very extensively diffused. A few important localities, which have not yet been examined by myself or assistants, are therefore omitted in the following notices.

Dorset.—Mr. Curtis, who has a furnace in North Dorset, shewed us a remarkable vein of this ore mostly disintegrated, and converted into ochre. The rock, in which the vein is situated, belongs to the Stockbridge limestone formation, is argillaceous, and has a slightly brownish tinge, with ferruginous stains. The direction of the strata is north and south, and the dip about 12° east. There are two systems of joints, which, with the planes of stratification, divide it into rhomboidal blocks. The vein has a direction of N. 30° E., is nearly perpendicular, and is about three feet wide, running through a hill, which is parallel with, and near, the western ridge of the Green Mountains. The vein has been opened by Mr. Curtis at the northern extremity of this hill, a few rods east of his furnace and of Otter Creek. It has been penetrated, horizontally, 150 feet, to a depth, under the steep acclivity of the hill, of 100 feet. Notwithstanding the extent to which it has been penetrated, it was found to be, with the exception of a thin streak of solid ore in the middle, in a state of perfect disintegration, consisting of clayey ochre, yellow above and reddish beneath. Mr. Curtis has seen the same vein nearly half a mile south of this opening.

On many accounts this is a remarkable case. It is the only example of a true vein of ore, which we have seen in this formation. The redness of the ochre in the deeper parts of the vein indicates, (although I am not fully satisfied that this is the true theory,) that it was once a vein of the red or specular oxide of iron, which has been subsequently converted into brown ore,—a change well known to the mineralogist to require only a combination of the red oxide of iron with water. It is very remarkable that the vein has been decomposed to so great a depth. Even the most cautious would have anticipated the discovery of solid ore.

Some years since, a bed of yellow ochre was found a few rods west of the above-mentioned vein, and a large quantity removed, but solid ore, in workable quantity, was not obtained.

The furnace is supplied with ore, partly from Wallingford, but mostly from the bed in East Dorset, three miles south. The ore of that bed is associated with ochres and white clay, and is much comminuted. About three tons of ore are required for one ton of iron.

Wallingford.—About half a mile east of the south village and of Otter Creek, is a valuable bed of ore, in a region thickly strewn with "hard-heads"—bowlders of granular quartz. Mr. Vail politely conducted us to the mine, and through the adit, which has been carried 27 rods in an easterly direction into a steep hill. For the first six rods it passes through drift and other loose material; for the next six rods, through limestone rock, which dips about 60° to the east, and is more or less arenaceous and ferruginous. For the remaining fifteen rods, the adit passes through red and yellow clayey ochres and white clay, until it reaches the fragmentary bed of manganese and iron ore. The clays and ochres are more or less distinctly stratified, conformably to the limestone rock, which they overlie.

Much of the ore of this mine, called "black ore," contains a large proportion of manganese. Iron made from it is very white, splendent, brittle, and excessively hard, scratching common window glass. The iron made from the purer ore is very tough.

Pittsford.—In our explorations in this town and in Chittenden, Drs. Armington and Ewing, politely conducted us to the various places of interest. In the east part of the town, Granger's furnace stands on an extensive bed of ore. It is a singular fact that this ore was not discovered until after the erection of the furnace, which was first, as it is at present, supplied from Mitchell's ore bed in Chittenden. Mr. Granger showed us the situation of the ore at his furnace, which is found beneath the drift, in a bed of yellow ochre, associated with white clay, and has rarely been penetrated: where it has been, it is found to rest on limestone. Furnace River, which furnishes ample water power, has cut through the deposit, and the ground is otherwise uneven, so that the ore has been removed by horizontal adits. The limestone here, as in other localities of ore, has a ferruginous tinge, and is covered, more or less, with ferruginous stains. Mr. G. considers the proximity of limestone indispensable to success in discovering ore beds.

About 60 rods north-east from the furnace, large quantities of ore were formerly removed from beneath the drift, on the south-west side of a hill of limestone, whose stratification is obsolete, but probably has a dip of 50° or 60° east.

We were informed by Dr. Drury, that lumps of brown iron ore are abundant in the soil on the Drury farm, two miles south of Granger's furnace, near a limestone ledge. The specimens exhibited appeared to be of good quality.

Two miles north-east from the furnace, by the side of the river, is the Hitchcock bed of brown iron ore and manganese, which was formerly worked by horizontal adits, penetrating the drift in the south side of the hill.

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, 60 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° east, 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 siliceous 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 ochrey 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 80 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 75 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 40 to 45 per cent. of iron being obtained from it. At present Mr. G. mixes with it a portion of the magnetic 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 re-melted. Such an arrangement may perhaps be introduced into some of our forges, in which there is much waste in the slag.

At Larned's forge, on Furnace River, the ore from this bed was formerly mixed with the magnetic ore from New York, but is now used alone, affording iron, which was said to be of excellent quality.

BRANDON.—A very slight examination only has yet been made of the rich metalliferous district in the east part of this town, whose prosperity is mainly the result of its rich deposit of iron ore, manganese and marble, developed by the sound practical knowledge and enterprize of its citizens.

The ore-bed of Mr. C. W. Conant is associated with the same variety of limestone before noticed as accompanying similar deposits. The surface of the rock is very uneven,—in some places at or near the surface of the ground—in others, at an unknown depth beneath the ore-bed, the bottom of which has not been reached. The exact relation of the ore to the rock is not therefore easily determined.

At a depth of 80 or 90 feet, the ore, although mingled with yellow ochre, and some of it finely comminuted, is quite free from admixture with the overlying deposit of drift. This would seem to indicate a near approach to the solid bed of ore, if such there be, from which the fragments originated. Large nodules also are common, whose cavity is completely filled with water—a fact which seems inconsistent with the theory of a powerful igneous agency exerted on the hematite, subsequently to its original deposition; although, under great pressure, it is perhaps possible, that nodules full of water may have been intensely heated without explosion. The occurrence of nodules, thus filled, was mentioned by the workmen as a very common occurrence. They have also been observed in Chittenden.

The very ingenious arrangement of Mr. Conant for washing the ore, has attracted much attention from visitors. A long box, open at both extremities, with the sides perforated like a strainer, is made to revolve in an inclined position, while a stream of water passes through it. The ore is thrown in at the upper end, and is, of course, rolled over and downwards while being washed, and falls from the lower extremity into a shallow vat. The ore thus washed, yields 50 per cent. of iron.

LEICESTER.—We were informed that a bed of brown ore has been opened in this town, but have not yet examined it.

SALISBURY.—Brown iron ore has been found in this town, but the locality has not been examined. A good specimen was brought to the geological depot by Mr. Huntly.

RIPTON.—Some ochrey sediment of water issuing from deposits of gravel, as at Mr. Bacon's saw-mill, have been supposed to indicate *beds* of ore, but no confidence can be placed in such indications, since the ochre may be derived from the iron which is so frequently disseminated through beds of gravel.

BRISTOL.—In the north west part of this town, between New Haven and Monkton, the brown ore was formerly worked to a considerable extent. It occurs beneath the drift, and partly under a soft rock, composed of clay and carbonate of lime, covered with the ferruginous stains, and much resembling the limestone so frequently found with brown ore, but very friable when moist, and much split up by irregular seams. Some years since a descending adit was dug under this rock, which fell through and killed one of the laborers. A frame had been carried along, but it proved insufficient, when the slight cohesion of the fragile rock gave way. If, as we have before intimated, the limestone rocks associated with our brown ores are undergoing disintegration, this example should serve as a caution in all cases where such rocks are penetrated. In one respect the geological position of the Bristol ore is different from that of the beds above described. It lies between high ridges of a peculiar variety of quartz rock, which is highly vitreous, translucent, and of a greyish blue color. This rock extends northerly into Monkton.

The Bristol ore is much injured by the presence of manganese.

MONKTON.—About a mile north of the Bristol ore bed, and fifty rods north of the town line, is a bed of ore, overlaid by gravel, which was formerly worked very extensively. The want of drainage has long since prevented the working of the bed. As however there is reason to believe that the ore exists in a large quantity, it may hereafter be deemed worth the drainage. This would require a cutting through gravel of 100 rods in length. The nearest rocks are the translucent quartz above-mentioned.

About half a mile west of this ore-bed, on land of Mr. Martin Rutherford, there is said to be another bed of brown ore.

HUNTINGTON.—A bed of ore has been found on land of Thomas Mix.

COLCHESTER.—A specimen of brown ore having been sent from the east part of this town, we visited the locality and found the ore abundant. It is found in land belonging to Mr. Barnes, on the southerly slope of a hill, in an ochrey gravel, overlying a siliceous limestone. Through an extent of several acres, lumps

of ore are found plentifully, by turning over the soil. A day's work would produce several hundred weight of ore. There is great encouragement here for exploration.

MILTON.—While in this town we were hospitably entertained by A. G. Whittemore, Esq., who, with several of the citizens, accompanied us in an excursion along the banks of the Lamoille, north west of the village. Mr. W. discovered a deposit of brown ore extending about three rods along the river bank. Whether it will be found in workable quantity is uncertain.

HIGHGATE.—A few rods southeast of the mineral spring, this ore occurs in an ochrey earth in considerable quantity.

STRAFFORD.—A few rods below the great vein of pyrites on Coperas Hill, is a crust, several inches thick, of bog ore, which has petrified the roots, leaves, stems and fruit of plants. It has resulted from the decomposition of the pyrites, and is of little or no economical importance.

SHERBURNE.—On the side of the mountain west of the road and a mile south of the village, were supposed to be indications of iron ore. We found, on examining the spot, that in a wet place the accumulation of iron rust from the wash of the mountain had cemented portions of the soil and gravel. This case is mentioned as one of many, in which iron rust is no indication of a workable quantity of ore.

Magnetic Oxide, and Specular Oxide of Iron, both of these ores, the former influencing the magnet, and the latter not affecting it, are generally known as mountain ores. They occur in the primitive rocks, especially in mica slate, hornblende rocks, serpentine, talcose and chlorite slates. In serpentine and in primitive limestone, they usually occur in irregular masses, and dependence should not be placed on a quantity much exceeding the visible portion. In some cases, however, masses of magnetic ore are found of immense size, as the Iron Mountain in Missouri. It is also very commonly disseminated in minute crystals in talcose slate, and as iron sand in the soil of talcose slate regions. The best tough iron is made from these ores.

Specular iron ore is so called on account of its brilliant lustre, from *speculum*, a mirror. Varieties, which are deficient in lustre, are called *rea oxide of iron*, and if fibrous, *red hematite*. It may always be known from other ores of iron by its streak, which is red. *Red ochre* results from the disintegration of this ore.

Magnetic iron ore has a black streak. Some varieties are only attractable by the magnet—others possess polarity, and will attract metallic iron.

Specular ore, if absolutely pure, would contain 70 per cent. of

iron and 30 per cent. of oxygen. Magnetic ore, absolutely pure, would contain nearly 72½ per cent. of iron—the remainder being oxygen.

Magnetic ore is widely dispersed through a large part of the State, either as small octahedral crystals in the talcose and chlorite slates, or irregular laminæ and small fragments, or as iron sand. The following are some of the towns in which it has been observed: Plymouth, Stockbridge, Bethel, Rochester, Chester, Huntington, Bridport, Addison, Hancock, Rutland, and Brandon. Some of these are named only because the small quantities observed by their inhabitants have raised more or less of expectation.

Plymouth.—About 50 rods south of the north line of this town, a mixture of magnetic and specular ores has recently been discovered opposite the house of Mr. Kennedy, on land of Mr. Obadiah Spaulding. It is on the west side of a hill in limestone at its junction with talcose slate. The lower part of the hill is limestone, and at an elevation of 200 feet above the road, the slate appears dipping 70° east into the mountain. The strata adjacent to the limestone are filled with crystals of magnetic ore, and a rich vein of the mixed ores is in the limestone. More or less ore appears in several parts of the latter rock near the base of the mountain. A preliminary exploration may be made with little expense by removing the loose materials of the surface downwards across the stratification. The other rich veins and deposits of ore in this town, we have not yet examined.

Stockbridge.—A rolled fragment, six inches in diameter, of a very rich compact ore, was found by Dr. Fay, near his residence. As the fragment was found alone, there is little reason to hope for the discovery of the original vein.

Bethel.—Hon. E. D. Briggs of Rochester shewed us some fragments of heavy ore from the west part of Bethel. The fragments were numerous and angular, and the original vein is probably not far distant.

Rochester.—About 2½ miles east of the village is a hill of a hard serpentine rock, in the top of which is a large irregular mass of chlorite, containing the ore thickly disseminated, mostly in crystals. The mass of chlorite is a rod wide and three rods in length. A large quantity of loose crystals occur in a disintegrated portion of the chlorite. A portion of these loose materials, having been washed, were reduced at Lincoln, and yielded about 20 per cent. of good iron. Mr. Cooper, one of the owners, shewed me a razor, which he had made from some of the ore reduced in a blacksmith's forge.

Chester.—Dr. Robbins, of the north village, shewed me crystals of this ore thickly disseminated in chlorite, and similar to the Rochester ore.

Warren.—In the northwest part of this town, on land of Mr. Pierce, a quantity of magnetic ore was discovered by Wm. B. Tyler, Esq. to whom we are under great obligations for valuable aid in examining this town. On the southern slope of the hill is an irregular vein of common quartz, parallel with the strata of the talcose slate, in which it occurs, the direction being north and south. Fragments of the slate, with irregular thin ribbons of ore, are enveloped in the quartz. Proceeding up the hill we saw numerous fragments of quartz containing laminæ of ore. Near the summit, the ledge is exposed, where Mr. T. had taken out 100 lbs. of good ore, which appeared to be a vein, but terminated abruptly at both extremities, and quickly wedged out beneath. This was also in white quartz, probably a continuation of the vein before mentioned. Although the direction of the quartz vein corresponded with that of the slate, the dip was opposite. The existence of ore in workable quantity at this place is doubtful.

Huntington.—Minute quantities of this ore has been found on the mountains by the citizens, who have manifested in the objects of the survey an interest worthy of being rewarded with a rich vein of ore. But we are compelled to say that the indications of magnetic ore are not very encouraging.

Bridport.—On Snake Mountain Mr. Frost found in the soil a fragment of rich granular ore. There is little encouragement to look for its source.

Addison.—At Chimney Point on the shore of Lake Champlain, *iron sand* is found plentifully. As a writing sand, it is not inferior to any in use. It has also been used as a coloring ingredient in mortar in St. Stephen's Church, Middlebury.

The origin of this sand is perhaps in the rich iron district lying northwest on the opposite side the lake, although the interposition of the deepest parts of Lake Champlain might be deemed an obstacle to its transport. Perhaps it may have been dispersed during the period of drift agency.

Hancock.—After a rain the wash of the turnpike is found to contain much iron sand, which was supposed to indicate a body of ore on the mountain. Proceeding from H. to Middlebury immediately after a shower, I traced this sand continuously from H. to two miles west of the summit of the mountain. Its origin is probably in the small crystals of ore, which are extensively, although not thickly, disseminated in the talcose slate of this region. Although large quantities are washed down in the course of the year, it is not an indication of any workable vein of ore. Similar cases are very common.

Brandon.—On the top of the Green Mountain in the east part of Brandon, in hornblende slate, is a vein 8 feet wide, consisting

of a mixture of hornblende and magnetic ore, with a direction of north and south, parallel to the strata of slate. Owing to the fusibility of the hornblende, several hundred weight, which were put into a forge, became a very liquid slag, no iron settling from it.

Specular iron ore has been observed in Chittenden, Brandon, Middlebury, and Lincoln. Also a range, which perhaps is more or less continuous, commences in Milton and extends in a north-easterly direction through Franklin County into Canada. The locality in the north part of Plymouth is sufficiently described in connection with the magnetic ore.

Franklin Co. and Milton.—In the north-west part of *Milton*, on land of Mr. Orange Phelps, is a valuable bed of the variety *red oxide of iron*, in a cream colored siliceous limestone, within a few rods of the margin of Lake Champlain. The ore is of good quality, and probably exists in large quantity. Several years since, about 60 tons were taken out. Before a thorough exploration can be made, it will be necessary to burn over the ground, which is covered with an undergrowth and thick bed of leaves. The vein (or bed?) has an inclination of 10° or 12° south-east, the direction being north-east. The sides are not regular or distinctly marked, and consist of a mixture of ore and siliceous limestone, which may be useful as a flux. The middle of the vein consists of a rich heavy ore.

The same variety of ore was shewn us by Dr. Ellsworth on his land, a few rods north-west of the village of West Berkshire. It is in a talcose slate, probably of the Taconic System. Some rich portons of ore appeared at the surface, but being covered with moss, earth, leaves, and the forest, we can only say that there is encouragement for exploration. Messrs. Hall and Thompson examined another locality a mile south-west of this, and a third in a north-east direction, in this town. They also found the same in Fairfield.

It is probable that the ore of these localities belongs to a continuous range; for the rich specimens collected by my assistants and myself have a remarkable similarity of appearance, and the direction of the several parts coincides with the line uniting the whole. A practical inference will be, that we may expect the discovery of ore in other portions of this line, which extends from the north-west corner of Milton through Berkshire into Canada.

Chittenden.—In the west part of this town, on land of Mr. Joel Leonard, the granular quartz rock, of the western slope of the Green Mountains, contains masses of specular iron ore, both finely granular and crystalline. Several hundred pounds had been removed, but there was no regular vein, and the mass was soon exhausted. This locality is of much interest in a scientific point of view, since the crystals have the form proper to the magnetic ore. Although regular octahedrons, they yield a red streak, and do not affect the magnet. It is a case of pseudomorphism, probably by chemical change of the protoxide of iron in the (originally) magnetic ore to the state of peroxide. If the agency of heat was requisite to such change, we find the effect of it also in the quartz rock, which has here been so far fused as to have lost its stratification.

Rutland.—At Sutherland's Falls, Mr. Jos. Humphrey showed me a specimen of red oxide of iron, which was found half a mile west of the falls, with an extensive bed of red ochre. The latter, resulting from the disintegration of this ore of iron, may be regarded as a favorable indication.

Brandon.—Good specimens of this ore have been brought to me from the mountain in the east part of the town. It is associated with calcareous spar, and is found in irregular masses.

Middlebury.—On land of Mr. Allen Foote, about three-fifths of the ascent of the mountain, directly east from the village, is a ledge of siliceous limestone, within the mica slate range, and containing this ore in small irregular laminæ. It will not probably be found in quantity.

Small laminæ have also been found in Avery's Gore, near Lincoln.

CHROMIC IRON.

This is an ore of great value, not for the iron, but as affording a basis of chrome paints, as chrome green and chrome yellow. It occurs only in serpentine rocks. It has been found in Newfane, as I was informed, but not in large quantity. Messrs. Thompson and Hall saw it in Westfield. When our extensive ranges of serpentine rock shall be thoroughly explored, we may hope for valuable discoveries of this mineral.

MANGANESE.

The most important ores of manganese are *pyrolusite* and *psilomelane*. They occur both in primitive and and secondary formations, often associated with brown iron ore, and mixed with each other.

Pyrolusite, when absolutely pure, consists of 36 per cent. of oxygen and 64 per cent. of metallic manganese. Psilomelane contains 10 to 20 per cent. of water and earthy minerals, and the remainder is similar to pyrolusite. It is much harder than pyrolusite, and from its composition might be supposed to be of less value. Nevertheless, Mr. C. W. Conant informs me that it is more esteemed in the market.

The principal use of manganese ores is in the preparation of chloride of lime, (bleaching powder). Manganese, diluted oil of vitriol, and salt, are put into an alembic. Chlorine gas is evolved, and conducted by a tube into an air-tight chamber, in which are shelves covered with freshly slacked lime, which absorbs the gas. Chloride of lime, thus prepared, is useful not only for bleaching, but as a disinfecting agent. When used in families, it should be made with water into thin paste, and the room or cellar to be purified, closed for a few hours, and then ventilated. Ink and most vegetable stains may be removed from printed books and white cloths without injury.

Manganese ore is also useful to the glass-maker to correct the green tinge occasioned by the presence of iron. Of course, the manganese should be free from iron.

A certain proportion of manganese gives glass an elegant violet or amethystine color, and a larger quantity gives a black color. It is therefore used for violet and black enamels of pottery.

The value of manganese is estimated by the quantity of chlorine gas evolved, when treated with hydrochloric (muriatic) acid, (an acid, which is formed by the action of oil of vitriol on salt.) One hundred parts of pyrolusite, absolutely pure, will disengage about 81 parts of chlorine.

When manganese was first discovered in this State, the use of it was not known. In Bennington, many tons of it were thrown into a brook, near the iron ore bed in which it was found, and irrecoverably lost. In Chittenden, it was supposed to be an ore of iron, and accordingly was put into the furnace in Pittsford. The only result any chemist would have predicted, viz: a most intense heat in consequence of the oxygen disengaged from it by the ordinary heat of the furnace.

Manganese wad is an impure earthy black ore of manganese, formed from the other ores, much as bog ore is formed from other ores of iron. It is used in England. Specimens have been received from two or three localities in this State, which have not been examined. Their value must of course depend on the purity and quantity of the manganese wad.

The best manganese is worth $30 per ton.

Manganese occurs in Bennington, Wallingford, Castleton, Pittsford, Chittenden, Brandon, Goshen, Bristol, Monkton, and Plymouth, and may probably be found in many other towns. The psilomelane is more abundant in most cases than the pyrolusite.

Wallingford.—Its situation here has been described, as associated with brown iron ore. It has been obtained only as intimately mixed with that ore, and is not used.

Pittsford.—In the Hitchcock ore-bed, before mentioned, it was formerly obtained in quantity. The bed is not worked at present.

Chittenden.—In the galleries of the Mitchell ore-bed, as described above, large quantities have been obtained. Here, however, it was so intimately mixed with the iron ore, as to render necessary the very tedious process of picking out the manganese by hand from the ore, which was first finely broken up by rollers. The particles of ochre were removed by repeated washings in sieves. During the last season, the working of manganese has therefore been abandoned.

About 80 rods north-east from the Mitchell ore-bed, is a *vein of manganese*, nearly two yards wide, in a very loose arenaceous quartz rock, associated with an impure siliceous brown iron ore. This is a case of great interest, since all the other deposits of manganese in the State consist of detached fragments.

The rock in the immediate vicinity, in place, is a calciferous quartz rock. If the calcareous portion were dissolved and washed away, it would leave an arenaceous quartz, like that which contains the vein of manganese. This fact, and those before mentioned in describing the situation of the brown iron ore and associated stratified clay and clayey ochres, suggest a hypothesis of their origin, which future investigation may or may not confirm, viz: that the rocks, originally containing these deposits, were composed of limestone and clay or sand, with these ores and ochres, and that the calcareous portions have been dissolved and removed by the quiet action of carbonated water, leaving the rest of the materials in their present condition. This would account for the occurrence of unconsolidated strata in so ancient a system as the Taconic rocks, to which, from their geological position, they evidently belong, and for the partial action on them of the drift agency. Professor Shephard, in his very valuable report on the Economical Geology of Connecticut, describes the rich beds of brown ore, which are there found in a continuation of the Vermont range, as interstratified with mica slate. May not the strata, which contain the ore, have been originally calciferous, and subsequently become unconsolidated in the manner above suggested?

We have dwelt longer on the position and original condition of the brown iron and manganese ores, because a true theory must have very important practical applications, both in the discovery and in the mode of working the beds. The anterior source from which they were transferred to the Taconic rocks, involves a question which we are unprepared to discuss, and which is of less economical importance.*

* It may be proper to state, that, in the examination of the interesting ore-beds of *Chittenden*, I was accompanied by President Hitchcock, who must therefore come in for a share ("the lion's share") of the merit, if any there be, of these investigations.

The vein above mentioned, which probably contains a great quantity of excellent manganese, unfortunately requires expensive drainage before it can be worked, and has therefore been abandoned.

BRANDON.—Immense quantities of manganese have been obtained in detached fragments from Conant's ore-bed. The situation is similar to that of the iron ore. The quantity removed depends on the state of the market, and during the present year the bed has not been worked.

BRISTOL.—Manganese occurs in the brown iron ore-bed, as before described, much contaminated with iron ore. Also a fragment weighing a pound or two was found in Drift in the hill east of the village. Unless other fragments should easily be found at the same place, it would not be expedient to be at any expense for exploration.

COPPER.

Copper pyrites, a compound of copper, iron, and sulphur, resembling brass, is usually found in mica slate and argillaceous slate, often in connection with iron pyrites, which resemble it, but which is of a lighter color, and has a black streak. Although copper pyrites yields only 6 to 12 per cent. of copper, it is the source of most of the copper in use. It is most abundant in Cornwall in England, which annually furnishes 9,000 to 10,000 tons of the metal. Copper occurs also in a native state, and as beautiful green and blue carbonates.

STRAFFORD.—Mr. Reynolds, agent of the copperas works, has discovered *native copper* in small quantity on Copperas Hill. A single loose fragment was found, weighing about 4 oz.;* the rest occurs in dendritic coatings or sprigs, in the thin seams of a mass of common quartz, which lies in the great vein of iron pyrites. It will not be of any economical importance.

Copper pyrites is disseminated through the same vein of iron pyrites, more abundantly in the east side of the vein. A few years since, furnaces were erected for the smelting of the copper pyrites, and several tons of metal were obtained. But the ore is so lean, being widely dispersed through the iron pyrites, that the cost of the process exceeded the value of the metal.

Minute portions of copper pyrites have been found in the Green Mountains, in Middlebury and in Brandon.

LEAD AND SILVER.

Galena is the only ore of lead of economical importance. It

*Some doubt has been suggested of the origin of this specimen,—that it may have been placed in the ground for deception: the situation of the dendritic coatings is matter of personal observation.

is a compound of metallic lead and sulphur. In color and lustre it resembles the metal, but is brittle and crystallizes in cubes. This ore is found most abundantly in the palæozoic and older secoudary rocks.

Galena frequently contains silver, from 20 per cent. to very minute portions. Argentiferous galena, however, cannot be distinguished by the eye from that which is destitute of silver. It is most common in primitive rocks.

Galena has been found in small quantity in Thetford, Morristown, Chittenden, Middlebury, and Brandon. It is not probable that it will be found in quantity, but it is probable that it contains silver. Specimens will be analyzed as soon as practicable. So small, however, is probably the quantity of this ore, that, unless much richer in silver than the ores of New-Hampshire, they will be of no value.

Silver also occurs either native, or in combination with sulphur, for the most part in the primary and palæozoic rocks; but has *not* yet been found in this State. Spangles of mica are frequently mistaken for native silver; but they are elastic, and, however brilliant, want the metallic lustre. Some of the paler kinds of iron pyrites are also mistaken for silver, but are always more or less yellow, brittle, and have a black streak.

Much money has been foolishly squandered in digging for silver, where there was not the least probability of finding it. In the east part of Brandon is a famed "money bed," not inappropriately so called, for the money lost here would have been a handsome addition to the funds of a Geological survey. After much mystery and secret excavation, a quantity of iron pyrites, 'fool's gold,' was found, and carefully locked up in a small building on the premises. How the contents of this building have been ascertained may be a mystery to the operators, but we have been certified by one who knows, and we can assure them that iron pyrites does not require lock and key for safe keeping.

GOLD.

Gold is usually found, in grains and lumps, in the sands of rivers and in drift; also in a gangue of quartz in Talcose slate, as in the Southern States. Iron pyrites is frequently mistaken for gold; we have already mentioned its characters which distinguish it from the precious metal: it has a black streak and is hard and brittle. Gold is easily separated from sand by washing. On account of its great specific gravity it settles to the bottom, while the earthy particles are poured off.

SOMERSET.—Some years since, President Hitchcock obtained a few particles of gold from the soil in this town. It has been

suggested that the gold had been placed there for purposes of speculation. On the other hand, it is said that the soil was covered with grass, which had evidently been undisturbed; and that the geological formation is similar to that of the gold region of North Carolina.

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.

ANTHRACITE AND BITUMINOUS COAL.

Although small quantities of mineral coal have been found in several formations, it is worked to profit only in a group of strata lying near the lower extremity of the series of secondary rocks and called the carboniferous group. Anthracite has been, in some cases, regarded as a product of the palæozoic rocks, but of late the rocks containing it have been regarded as metamorphic members of the secondary formations.

The practical geologist often hears of "indications of coal," and not a little useless expense of explorations and disappointment of groundless hopes might be saved by a correct knowledge of the subject. There *are* indications of coal, on which some reliance may be placed; but any fancied resemblance to coal in the color or lustre of rocks, as it is an appearance common to many of the slates, which never contain coal, is not to be trusted.

The first question is—whether the rock to be explored for workable coal can be referred to the proper series of coal-bearing strata. If it cannot, the question is settled in the negative. *No coal formation exists in Vermont, and consequently all exploration for coal will be useless expenditure.* In proper coal formations, petrifactions of plants, which resemble ferns and large reeds, may be expected in connection with coal. Lastly, the surest "indication of coal" is the visible presence of it in beds alternating with the rocky strata.

Norwich.—The existence of anthracite in this town had been published in Mr. Thompson's Gazetteer. Dr. Davis, who has given much attention to the minerals of this vicinity, informed us that about half a bushel was obtained from thin layers in argillaceous slate, in the northwest part of the town. The fact is therefore well authenticated.

Hinesburgh.—Mr. R. M. Owen of Williston informed me that on his land in H. there was a bed of coal. From his description of it, I think it possible that there may be some brown coal there.

SALT.

This valuable substance is found in solid deposits in the New Red Sandstone and in the Tertiary strata, as well as in some intermediate formations. In New York, salt springs issue from the palæozoic rocks, but not from the *base* of that system of rocks, which only we have in Vermont. *It will probably be useless to look for salt in this State.* We believe the boring for salt in the capital of the State, some years since, was satisfactory to all concerned.

GYPSUM.

Gypsum (Plaster of Paris) occurs in the tertiary, New Red Sand stone, and some of the palæozoic formations. *Probably it will not be found in quantity in any of the rocks of Vermont,* for, wide as is its range in the series of stratified rocks, no formation, in which this mineral has been found in workable quantity, exists in the state.

GRAPHITE.

This valuable mineral occurs mostly in primary and palæozoic rocks. It consists chiefly of carbon, about 96 per cent., with a little iron. It is improperly called black-lead, or plumbago. It is useful for lubricating machinery, for giving a gloss to cast iron, and as a material for pencils and for crucibles.

In the east part of Brandon is a locality, which we have not yet examined, but which is probably valuable. The specimens, which we have seen, are argillaceous; a property, which will be of little or no injury to the article. In Norwich, Dr. Davis shewed me specimens of impure graphite in mica slate, said to exist in large quantity. In Huntington impure graphite also occurs. At Larrabee's Point in Shoreham, Mr. Wilcox annually manufactures many hundred gross of pencil-leads, procuring the material from Ticonderoga, (N. Y.) where it is found of very superior quality.

One of the most valuable mines in the world of this mineral is at Borrowdale in Scotland, where, in consequence of the lawless character of the inhabitants, tempted by the richness of the mine, it has become necessary to erect a strong building, through which only the mine can be entered by a trap door. The miners are required to change their dress under inspection as they come in and go out, and the two men, who are employed in sorting and dressing the graphite, are locked in during their work, and watched by a steward, from an adjoining room, armed with two

loaded blunderbusses. The mine is worked only six weeks in the year, sometimes yielding to the amount of $150,000 to $200,000. The price in London has been about $7.00 per lb. The Brandon graphite is retailed in this state at 12 cents per pound.

OCHRES.

Yellow or brown ochre results from the disintegration of brown iron ore, and red ochre from the specular or red oxide of iron. They contain also more or less of clay. Artificial ochres may be made by pulverizing these ores, and the yellow ochre may be converted into the red by the heat of a reverberatory furnace. A red chalk, which is used by carpenters, is probably prepared from pulverized red oxide of iron with sufficient clay to give it cohesion; but the process is said to be secret.

The characters and situation of many beds of ochre, as connected with the iron ore beds, have been described. None of these, however, are now wrought to any considerable extent. The proximity of BENNINGTON to a market, and the vast quantity existing there, will probably, for some time to come, give it the advantage. About 500 tons per annum are prepared here. Mr. Adams, who prepares 200 tons per year, very obligingly accompanied me to his ochre-bed, and showed the process of preparation.

The works are about one and a half miles north-east from the east village of Bennington, on the west side of a hill of drift, which is thickly covered with quartz bowlders. The earth, consisting of yellow ochre and sand found beneath the drift, is removed through adits, which enter the side of the hill. This is done during the winter, and the process of preparation occupies the summer. The crude ochre is placed in an elevated vat of water, and broken up and thoroughly mixed with the water, by a frame revolving by water power. The sand settles, and the ochre is drawn off into vats a little lower. Here it stands long enough for a complete separation of the sand, when the ochre is drawn off into other vats, where it stands until it has subsided from the water, which is then drawn off from the ochrey sediment. The wet ochre is then shovelled into shallow trays, in which it is first dried by the sun, and subsequently on shelves under a roof. A stone mill reduces the lumps to an impalpable powder, which is put up in casks containing 800 lbs., and sold at $25.00 per ton.

Other beds of ochre and brown iron ore exist in the immediate vicinity. The bottom of the bed now wrought has not been reached.

MOULDING-SAND.

Very good moulding-sand is found in Middlebury, about 80 rods south-west from the college; but the supply is limited. On the Drury farm in Pittsford, is a moulding-sand, which "blows" some, but is considered inferior only to the Waterford sand. A mile south-east from Greensborough mills, on land of Mr. Hale, is a ridge of moulding-sand, apparently of excellent quality, but I am not aware that it has been tested. On the low sandy grounds south of Lamoille village, may perhaps be found a sand suitable for this purpose.

ROOFING AND WRITING-SLATES.

The south-east part of this state has justly been celebrated for its roofing slates. There are several quarries in the argillaceous slate, which are more or less wrought; but the expense of transportation to market renders them at present of comparatively little value, except for the supply of the vicinity. The opening of the Brattleborough rail-road will doubtless add greatly to their value, and however extensive the demand may become, the supply cannot fail.

Several of these quarries present the remarkable appearance of having been crushed over, by a force acting from above to the west north-west. Many interesting details of this phenomenon have been journalised, which cannot be introduced here.

To Messrs. C. C. Frost of Brattleborough and Pierce of Bruce's quarry, many thanks are due for their aid in the examination of the quarries in that vicinity.

The Taconic slates towards the western part of Rutland county are also very valuable.

GUILFORD.—Bruce's quarry has been very extensively wrought, but at present only one person is employed in getting out slates. The laminæ (strata?) are very regular—have a direction of north 5° east, and dip 72° west. Constituting an elevated ridge, parallel to and within five to ten rods of an excellent road, they are quarried and removed with great facility. The layers are very uniform, and slates of any required dimensions may be obtained. On account of a fine grit, they cannot be planed and used for writing-slates.

Willard's quarry, near the Brattleborough line, which has been wrought nearly forty years, at present employs two men. Good slates are obtained here with rather less facility than at Bruce's quarry.

BRATTLEBOROUGH.—Several ledges of slate in this town have been worked to meet occasional demands.

DUMMERSTON.—At Clark's quarry, a little north of the Brattleborough line, three men are employed. Good slates are obtained here; but the quarry requires drainage, which is effected by a siphon. Sixty rods north-east from this is another quarry, not worked at present.

FAIRHAVEN.—About a mile north of the village, is a quarry of excellent writing and roofing-slate, of green and chocolate colors. Mr. Royal Bullock shewed us specimens of writing-slates, planed with a machine of his invention. They are smooth and soft, of a chocolate color, occasionally with green spots, which, unlike the green spots in the Welsh slates, are as soft as the other parts. Preparations are made in this village for manufacturing writing slates in quantity. The same material is equally useful for slate-pencils. Roofing-slate also may be obtained.

In Rutland is a manufactory of slate-pencils, the material being the green Taconic slate from Hubbardton.

FLAGGING-STONES.

The slate-rocks, both of the Taconic and primary systems, will furnish good flagging-stones, whenever there shall be a demand for them. That there is not a greater demand certainly is not because they are not needed in many of our villages. Some of the finest stone for this purpose is a silver-colored mica slate, in the south part of Chester, which much resembles the flagging-stones so extensively quarried in Bolton, Connecticut.

WHETSTONES.

In the south part of Stockbridge, on land of Mr. Esty, is a fine-grained Talcose slate, in which the quartz is arenaceous. Varieties of this slate are made into excellent scythe-stones, hones, &c. The Talcose slates of the middle parts of the State, will probably furnish other localities.

FIRESTONES.

Firestones of good quality are a great desideratum, especially in the vicinity of the numerous iron-works west of the mountains. A good firestone must be infusible in the hottest furnace, and must not spalt, or split into fragments. Many of our Talcose slates and soapstones possess the latter quality, but are too fusible for blast furnaces. The Taconic quartz rock is sufficiently infusible, but spalts. The tymp-stones of our furnaces, requiring the union of these two qualities in the highest degree, are brought from Strafford, Connecticut. They are an arenaceous

quartzose talcose slate. A rock of similar constitution has been found in the east part of Brandon, but is perhaps too hard to resist the fire without splitting. The new red sandstone of Haverstraw, New York, is more or less used for hearth-stones, and the Potsdam sandstone from Mount Defiance, New York, is used for lining the furnaces. The Taconic quartz rock differs little from the Potsdam sandstone, except in being more compact; but it is this quality which injures it as a firestone. Some of the less compact varieties may answer as a substitute. The excellent fire bricks, which are manufactured in Bennington, are also used in blast furnaces.

For the more ordinary degrees of heat, as in kilns and fire-places, many talcose slates are excellent firestones, as that of Roxbury, near the serpentine ledge. Most of the towns next east of the Green Mountain ridge, as well as many, which are situated on the Taconic talcose slates, as the eastern part of Franklin county, contain such firestones in abundance.

It is important, in the use of slaty firestones, to lay them with the edges directed towards the fire. In this way, even slaty limestones withstand a strong heat, as at Larrabee's Point in Shoreham, where they are used in the arch of a lime-kiln.

Another rock, well known as an excellent firestone for domestic purposes, I describe under a distinct head, viz:

SOAPSTONE.

Steatite or soapstone, so called on account of its greasy feel, is one of the softest minerals, being easily cut with a knife. It is a variety of talc, either granular, or composed of small elongated imperfect crystals. About one-third of it is magnesia, and the rest is silica, with two or three per cent. of protoxide of iron. Besides its uses as a firestone for lining culinary furnaces and stoves, and for jambs, it takes a good polish, and is an ornamental stone, although from its softness liable to be defaced. It is used in the manufacture of some kinds of porcelain, to render the ware more transparent, and also for polishing, for removing grease spots from woollen or silk, stoppers for chemical apparatus, &c.

This valuable mineral is usually associated with serpentine in talcose regions. It is very abundant in Vermont, through the length of the State. Several quarries are noticed in the subjoined report of Messrs. Hall and Thompson. The opening of the Central rail-road will add much to the value of many beds east of the mountains.

GRAFTON.—Mr. Walker obligingly showed us the two quarries which are wrought under his direction. They are situated two or three miles south-east from the village of Grafton, near the

summit of a lofty hill. The soapstone is in irregular and nearly horizontal beds. At the upper quarry it is of the finest quality. Here it is partly interstratified and partly overlaid with thin strata of dark green talcose slate, above which are conformable strata of hornblende slate, twelve feet thick, with a slight dip to the east. In the lower quarry, one-quarter of a mile to the north-east, the beds are thicker and probably inexhaustible, but the quality is said to be not quite equal to that of the other quarry. The blocks are cut out with a drill, (one man being able to cut about eight square feet per day,) and then split from beneath in the planes of stratification. Large quantities are carried to Bellows' Falls, and thence down the Connecticut river.

Bridgewater.—There is a quarry in this town, which has been abandoned for many years on account of the inferior quality of the stone.

Bethel.—In the west part of this town is a valuable quarry, which has been examined by Messrs Hall and Thompson, since the preparation of their report. Actinolite, associated with this steatite and of a very fine quality in abundance, will interest the mineralogist.

Rochester.—In the south-east part of this town is a quarry which is not wrought at present, although the stone is of excellent quality.

SERPENTINE.

This mineral is similar, in its composition, to soapstone, with the addition of water chemically combined. It is harder than marble, as a substitute for which it is sometimes used. The color is almost invariably some shade of green, the lighter and more translucent varieties being called 'precious serpentine,' and the dark varieties, 'common serpentine.'

On account of the immense quantities in some of the towns east of the mountains, as in Cavendish, Roxbury, Lowell, &c., the question of its utility is of great importance. A serious practical objection is that the rock is usually traversed in every direction by numerous seams, which split it into small irregular fragments. Occasionally, however, solid masses occur, but many of these are traversed by irregular strips of lighter color, which so much resemble cracks as to affect the sale of an article not yet well understood in the market. Objection has been made on account of its hardness, but this quality may increase the value nearly in the same ratio in which it increases the expense of polished slabs. This stone takes a fine polish, and is richly colored. For apothecaries' counters it is peculiarly valuable, not being affected by acids.

Roxbury.—One of the most valuable localities of serpentine is in this town, about half a mile south of the village, on the north-west side of a small pond. There are indistinct traces of a stratification (?) conformable to that of the talcose slate in which it lies. The ledge appears to be very compact and unusually free from flaws, and will, no doubt, be valuable whenever luxury shall be willing to meet the expense of polishing. It is probable that blocks of any required dimensions may be obtained. The quantity is inexhaustible. Small veins of a light yellowish green variety occur, which will furnish the mineralogist with specimens of extreme beauty. The rock has not yet been quarried, but a few blasts have been put in to develope its characters.

We were informed that there is another ledge, north of this, on land of Mr. Spalding.

Northfield.—Probably in the same range with the Roxbury serpentine, is a ledge in the west part of this town. A specimen was shewn to us in Mr. Pierce's store, which was of fine quality.

Rochester.—The chloritic bed of iron ore before described is in a hill of a hard red variety of serpentine, which is traversed by seams in such numbers, that it is of no value, even at a depth of 30 or 40 feet below the surface.

Cavendish.—Serpentine has been quarried in Proctorsville by Mr. Proctor, and large and elegant slabs have been polished. We have not yet examined Mr. P.'s quarry. On the north side of the road, half a mile west of Proctorsville, is a large *mountain* of common serpentine, containing hornblendic and talciferous varieties.

The above are but a few of the many localities, which extend through the state from north to south on the east side of the mountains.

MARBLE.

So numerous and extensive are the deposits of marble of superior quality, that only a very meagre sketch can be offered at present. The varieties are not very numerous as compared with the quantity. They depend on the chemical composition, color, structure, and geological position. Of the chemical composition, it would be premature to offer any remarks in anticipation of the analyses. It is probable, however, that a portion of the white marbles are magnesian, that is, are composed of carbonate of magnesia and carbonate of lime. Such will not prove as durable, as those which are composed wholly of carbonate of lime, the former being more friable.

The principal varieties are the following: pure white; white with thin clouds of greyish blue; greyish blue, often more or less

mottled with shades of different intensity. These belong to the Stockbridge limestone formation, and extend along the Taconic valley, west of the Green Mountains, from Massachusetts to the north part of Addison county. They are of a granular structure, rarely if ever too coarse for fine marbles, often fine enough for statuary. Its adaptation in quality to the purposes of statuary has been shewn in an exquisite piece of sculpture, of a crouching Venus, in basso relievo, by my friend J. G. Saxe, Esq. of St. Albans. Mr. S. says that the marble is "perfectly adapted to all the forms of sculpture, provided it is found in sufficiently large blocks."

Other marbles are black, finely granular or compact, sometimes with a coarse, peculiar granular structure, which is occasioned by the great proportion of comminuted fragments of organic remains. In a fresh fracture of the latter variety of structure, the organic character of the materials is scarcely distinguishable, but a weathered surface exhibits the organic fragments in relief, and a highly polished surface exhibits sections of them. Portions of the rock, which are destitute of such fragments, but which, perhaps, are derived from organic structures, comminuted into impalpable mud, are very compact. Some of the fossiliferous varieties beautifully exhibit the sections of shells, which are white and granular, in a compact jet black base. The difference of structure, however, renders it difficult to bring them to an even surface for polishing. One who is not familiar with black marbles, is surprised to see a greyish blue stone converted by polishing into a jet black marble. These marbles belong to the Champlain division of the New York system of rocks. There is at Swanton, belonging to the same division of rocks, a compact pale, dove-colored marble.

As the inquiry has often been made of us, whether a given stone be limestone or marble, it may be proper to add that any limestone, which will receive a good polish, *is* marble.

In the following very imperfect sketch, we shall speak of the marbles as belonging to the Primary, Taconic, and New York systems of rocks.

Primary Marbles.

Probably many of our marble cutters, who have been in the habit of calling the Taconic marbles 'primitive,' will be surprized at the statement that there are few primary marbles in the state. In excluding the Taconic marbles from the primary system, we do not affirm that they are known to be fossiliferous, but that they belong to a system, some of whose members are fossiliferous.

A white granular limestone, probably magnesian, of suitable quality for marble, has recently been discovered in the northwest part of MORETOWN, but my assistants, who have examined it, report that it consists only of a stratum not exceeding two feet in thickness, and is not workable. In WEATHERSFIELD is a white granular limestone, which is used for lime, but which perhaps might furnish white marble. In PLYMOUTH, besides the white limestone, which possibly might furnish marble, is the beautiful, variegated marble, now well known; but we have not yet visited the quarry.

Taconic Marbles.

These marbles occur throughout the range of limestone from Massachusetts to the north part of Addison county. We shall describe those quarries only, which we have seen.

DORSET.—Most of the white 'Manchester marble,' so called because it is sawed in Manchester, is quarried in Dorset, at various elevations on the south and east sides of Dorset mountain. Compared with the whole extent of marble, these quarries can be regarded as only slight openings.

It is difficult, while retracing in memory our visit to the quarry, which is situated near the cave in the south side and upper part of the mountain, to consider it simply in its economical relations, so picturesque, when viewed from the east village of Manchester, is the situation of the snow-white rocks surrounded by the green forest, at an elevation of nearly 1800 feet above the base of the mountain,—and so magnificent and beautiful, from the quarry itself, is the prospect, which extends from the rich, cultivated fields of Manchester below, through the Taconic valley to Bennington and into Massachusetts, limited on the left by the unbroken range of the Green Mountains, and on the right by the less continuous Taconic range, with Equinox Mountain as a near neighbor on the south-west, reaching a height of 4000 feet above the sea. All, that could be added to such scenery, was added by the breaking up of the dense clouds of a heavy shower, which fell while we were in the cavern, examining an ancient subterranean water course here in the top of the mountain, and which then permitted us to see the rare spectacle of the numerous small fragments of dense fleecy clouds hanging about the dark green sides of the neighboring mountains, and reflecting a pure white color in the rays of the reappearing sun, while the tempest was still heard forcing its passage through the deep and contracted valley to the north.

The ascent to the quarry, made by us in an exceedingly hot day and in a sultry stagnation of the air, which preceded the

shower already seen approaching far off in the south, was greatly facilitated by the winding road, which had been used for the transportation of the marble. We were accompanied by the Messrs. Chamberlain, proprietors of the quarry on the south-west part of the base of the mountain. The strata of white granular marble, separated in some instances by thin talcose layers, are, at this elevation, horizontal or with a scarcely appreciable dip to the west. They are of various degrees of thickness, from half an inch to two feet or more. From the level platform of the quarry, the refuse fragments had been thrown down an overhanging precipice of a hundred feet, and covered a steep talus or slope, for another hundred feet into the forest below. Some of the marble at the mouth of the cavern was found to be highly flexible, thin strata bending, when wet, to a radius of two feet.

This quarry is not wrought at present, as marble of better quality is obtained with facility near the base of the mountain.

The Messrs. Chamberlain send marble to New-York at an expense for freight of $5.00 to $6.00 per ton; also to Cleveland, Ohio, for $5 per ton from Troy. A ton of sawed marble will contain 60 to 70 superficial feet.

Rutland.—On the west side of the village of West Rutland is Hyde's quarry, which has furnished a great quantity of fine white granular marble, and which is now wrought very extensively. Many of the strata, which dip about 20° to the east, are several feet thick. The surfaces are more or less coated with talc, which appears also as a constituent, in very small proportion, of a few of the strata, giving them a greenish tinge. There are also some lilac-colored and greyish blue varieties; but white is the prevailing color, and the quarry, seen from the centre of the village, resembles a bank of snow. A dyke of greenstone, eight inches wide, with some irregularities, thinning off to five inches in its course to the west, cuts across the quarry.

Half a mile or more north of West Rutland village, *Dr. Sheldon* has recently opened a quarry of thick-bedded white granular marble, with greyish blue and greenish varieties. A huge pot-hole, eight feet in diameter, well rounded, and not formed by any existing stream, is a curiosity which will probably disappear in the working of the quarry.

Dr. Sheldon's quarry is on the west side of a hill of marble, which extends 100 rods farther to its northern termination, where is *Barnes' quarry*. The upper part of this quarry consists of beds of greyish blue marble, beneath which are fine-grained pure, white beds, one to four feet thick, dipping about 15° to the east. The blocks from the most valuable beds are cut out with drills, two feet of surface being a day's work. Some of these beds are of a quality suitable for statuary. An immense quantity of fine marble has been removed from this quarry. At present Mr. Barnes employs 35 hands.

Between the quarries of Dr. S. and Mr. B., the hill is a continuous range of marble, which can never be exhausted. A few rods north of Mr. B.'s quarry, the strata are deflected to the north-east, and the marble disappears.

Ormsby's quarry, at Sutherland's falls, a few rods south of the Pittsford line, furnishes a fine granular white marble with cloud-like veins of greyish blue. This beautiful variety is called at the quarry "Italian marble." Fine slabs of this and other marbles from the vicinity were shewn us by Mr. Joseph Humphrey, at the finishing shop. In polishing it the grit-stones of Ohio are used.

At these falls, a very small portion only of the immense water power, produced by Otter Creek falling 100 feet in the space of a few rods, is used for sawing marble, carrying eight sets of saws. The lovers of beautiful scenery will regret 'the march of improvement,' which is destined to convert this romantic spot into a gigantic hive of buzzing factories.

Pittsford.—In the north part of this town, near the Brandon line, is a hill of marble, which we observed for a hundred rods in length. This marble also is finely granular, white at the north opening, with very thick but irregular beds, having a talcose coating. At the principal quarry farther south, the greyish blue variety prevails, a noble specimen of which is the neat and elegant marble mansion of C. W. Conant, Esq., of Brandon. In these quarries the strata dip about 60° to the east, and as the quarry is on the east side of the hill, the blocks are removed with great facility. This marble is frequently called 'Brandon marble,' because manufactured in Brandon.

Brandon.—In the west part of this town are two adjacent quarries of statuary marble. It is of a pure white, and very fine grained; but many of the strata are too thin to furnish blocks of the largest required dimensions. Like much of the white marble in the other quarries of this region, it is highly saccharine, or more properly saccharoid—that is, resembling the whitest loaf-sugar.

Middlebury.—There are several quarries in this town, but the business is not carried on with so much vigor as formerly. Besides the white marble from the east part of the town, other varieties have been quarried in the village. Mr. Daniel Judd has a hall-table of the greyish blue variety, with a high polish, beautifully mottled with shades of different intensity. This stone was quarried under the bridge in Otter Creek.

Champlain Marbles.

The general character of the marbles of the Champlain division

of the New York system have been noticed. The following are some of the localities:

Shoreham.—A few rods south of Larrabee's Point, on the margin of Lake Champlain, is a quarry of black marble, which was discovered and wrought by Mr. Judd, sen. Shells of the genus *Maclurea* are sometimes found, and white crystalline casts of smaller shells are common, but much of the marble is free from them. In Mr. Judd's house in Middlebury, are very elegant mantle-pieces from this quarry. In one of them the pilasters are filled with a great number of the white crystalline casts of shells in the compact, jet-black base. In another, the frieze is entirely free from any fragments of shells, and is an absolutely pure jet-black, and for depth of color and brilliancy of polish cannot be surpassed. All the marble from this quarry receives a very high polish.

Benson.—While passing through this town, we were shewn at the post-office a specimen of a remarkably compact black marble, from the north-west part of the town, on land of Mr. Orrin Benson. Such stones as this specimen would undoubtedly take a brilliant polish, and become of a deep jet color.

North Hero.—We were informed, as we stopped at the tavern on the east side, that a locality of black marble had been found on the west side of the island.

Isle La Motte.—Our visit to this island was highly interesting, from the value of the quarries examined, and their great importance to scientific Geology, as well as for the interest manifested by the inhabitants in the objects of the survey, and for their generous hospitality. To Ira Hill, Esq., and to Mr. H. Hill, we are under especial obligations.

The black marble of this island is often called 'Swanton marble,' because it is carried by sloops to that place to be sawed. In 1844, the amount of marble from the Isle La Motte, sawed at Swanton by Wm. Van Duzee, and sent to New York, was 3300 cubic feet, which made 21,300 superficial feet of sawed marble, or 245 tons, and the amount of sales was $5839.

In many of the villages on or near the shore of Lake Champlain, this marble is used, rough or hewn, as a building stone.

Hill's quarry is on the east side of the island, at the margin of the lake. Blocks of any required dimensions are obtained with great facility. Several regular vertical planes of division cut through the quarry, and greatly diminish the expense of getting out the blocks. Along the middle of the quarry is a rounded north and south anticlinal axis, from which the strata dip on both sides 5° or 6°. Maclureas, some five inches in diameter, with fragments of other shells and of corals, fill the rock, while the surface, recently exposed by the removal of the soil and drift, has been smoothed down and covered with fine scratches by the drift

agency. Rough or hewn blocks from this quarry are used as building stones in the village. A new meeting-house, the school house, and house and barn of Ira Hill, Esq., are examples. The front of the latter building exhibits many fine Maclureas.

Cook's quarry is in the south-east part of the island. Here the strata have a direction of N. 65° E., with a dip of 4° or 5° only to the north-west. Commencing at the south-east extremity of this quarry, we find thick beds consisting mostly of comminuted fragments of corals, with encrinites, &c. Next is a stratum two feet thick, less compact, and of a grey color. Above this are the principal beds of the quarry, containing Maclureas abundantly and comminuted corals. Above the quarry is a limestone rock, not suitable for marble, containing large Orthoceras.

Fisk's quarry is on the south-west side of the island, very conveniently situated on the margin of the lake, with a wharf for shipping. This is the most extensive marble quarry in Vermont, and was wrought before the war of the Revolution. Mr. Fisk politely shewed us the points of interest, and we regretted that our arrangements did not permit us to accept his proffered hospitality.

The direction of the strata is nearly north and south, with an easterly dip of 5° or 6°. The rocks to a thickness of at least fifty feet consist chiefly of fragments of corals, with the Maclureas in abundance, and some small Orthoceras and other chambered shells. One Maclurea was seven inches in diameter. Blocks of marble of any required dimensions are obtained with ease.

Swanton.—In this town is a light dove-colored marble, belonging to another member of the Champlain division, which has been examined by my assistants.

Limestone.

This rock exists, in various situations and degrees of purity, in a majority of the towns in the State. It will therefore be impossible at present to go into all the details of its distribution and use, and our remarks must be restricted to the more general statements, which are necessary in addition to the foregoing sketch of our marbles. We shall here consider it only as the source of lime.

The varieties, which depend on the presence of other ingredients than carbonate of lime, have peculiarities, a knowledge of which is of great importance for practical purposes. The varieties are, besides common limestone or carbonate of lime without any important portion of impurities, magnesian limestone, argillaceous limestone, and siliceous limestone. In anticipation of the examination and analysis of specimens, we can offer but a very imperfect report on this subject.

Some of the characters of pure carbonate of lime were noticed on page 10. It contains 56.3 per cent. of quick lime, and 43.7 per cent. of carbonic acid. When a fragment is immersed in any of the common acids, the latter constituent is expelled in a gaseous form, producing effervescence. A strong red heat also drives off the carbonic acid, leaving the quicklime, which cannot be melted by any degree of heat that can be produced in a kiln or furnace. The familiar process of slacking lime depends on its affinity for water, with which it combines with great energy, deriving it from the vapor of the air, if not otherwise supplied. In this process the properties of the water are entirely changed, so that the slacked lime may be as dry as the caustic lime. Slacked lime, called by the chemist hydrate of lime, has the property of slowly combining with siliceous sand, forming a hard silicate of lime, and on this property the use of mortar depends. Lime also combines with carbonic acid gas, and will take it from the air, which contains only one-tenth per cent. of this gas. When quicklime or slacked lime is spread on land, it is thus converted into the same substance which it was before burning. The burning of it into lime, however, had reduced it to a state of subdivision far more minute than could have been done by mechanical agency, and therefore more beneficial.

Magnesian carbonate of lime usually contains 30 or 40 per cent. of carbonate of magnesia. Although the stone is less durable, the mortar made from it is said to be more so. Lime made from it is injurious to land, if used in large quantities; but the injurious effects are exhausted in two years, and the beneficial effects continue. If used in less quantities than common lime, it is not injurious. Acids and heat have the same effect on this variety as on common carbonate of lime. The product of the kiln consists of about two-thirds quicklime and one-third calcined magnesia.

Argillaceous carbonate of lime contains clay, the presence of which may be detected by its peculiar odor, when moistened by the breath. The per centage of clay is variable. Its presence is not likely to have much effect on the lime, unless to give it the properties of water cement.

Siliceous carbonate of lime contains variable proportions of siliceous sand, which, if not in large proportion, does not injure the lime for agricultural purposes, nor diminish the strength of the mortar made from this lime. The mortar will be more or less colored by the sand pre-existing in the rock, and will not require so much sand as a fat lime. Before attempting to make lime from a bed of siliceous limestone, specimens of the bed should be analysed, if there be any doubt whether it contains sufficient lime.

The greatest difficulty in the use of this variety is in burning it, but it is not a serious one. Although lime is one of the most infusible of substances, yet when mixed with sand, the mixture is melted at a moderate heat, and forms a kind of glass.* In burning a siliceous limestone, care therefore, must be taken not to raise the heat so high as to convert the stone into glass, and yet to raise a heat sufficient to expel all the carbonic acid. A white heat may be expected to spoil the charge. As some experience will be essential to success, it might be well for a few persons to give special attention to the burning of this kind of limestone.

Siliceous limestone is easily recognized by its weathered surface, which is covered with a grit like sand-paper, occasioned by the disintegration of the calcareous part of the surface.

It is probable that some of the varieties existing in this State will furnish abundant materials for the preparation of *hydraulic lime* or water cement. This kind of lime does not slack as common lime, but forms with water a pasty mass, which will not harden in the air, but only in water. The hardening takes place after a few hours in some kinds, in others after the lapse of several days, the latter kind being the best. Unfortunately the analyses of limestones which afford this cement and of the cements themselves do not indicate any precise constitution, as certain to afford this lime. It is generally thought that 20 or 30 per cent. of silica and alumina or magnesia are necessary, but some of these limestones appear to be nearly destitute of these ingredients. Resort therefore must be had to actual experiment, in the selection of the materials preferring impure limestones which have a gritty surface where weathered, and an odor of clay when moistened.

In burning lime the *intermittent kilns* only are used in this State, so far as we have seen. There is of course a great waste of heat in cooling off the kiln for every charge of limestone. Where fuel is abundant, and the demand for lime is small, this may be the best method. Common bricks are found to answer for lining, although fire bricks, such as are made at Bennington, and may be made from any of the numerous beds of kaolin, would probably be best adapted to a kiln in constant use. Between the bricks and the outer wall there should be a space filled with

* An apt illustration of the difference between the merely 'practical man,' (that is, one who, parrot-like, does every thing by rote,) and men of true science, who combine theory with practice,—occurred in an attempt to burn a kiln of siliceous limestone. A person was employed, who had had much experience in burning nearly pure white limestone, and reasoning only from his own experience was confident that the stone could not be melted. The result of his labors, which a little knowledge of chemistry would have prevented, was a kiln of half-formed glass.

ashes, to confine the heat and to prevent fracture of the outer wall by sudden heat.

The egg-shaped kiln is now preferred, having to some extent the properties of a reverberatory furnace.

The kiln should be built against the side of a cliff on which the stone can be drawn to the top; or on the side of a steep hill, raising the ground between the hill side and the kiln.

Where wood costs $2.00 per cord, the expense of burning lime in an intermittent kiln is about 8 cents per bushel. But in a *perpetual kiln*, (that is, one so constructed that the lime may be withdrawn, while the fire is kept up, and fresh stone added in portions of a charge,) the expense is about 2 cents per bushel.

The kiln, which is here represented, and whose size may be estimated from the scale of English feet, produces 250 bushels daily.

Fig. 2.

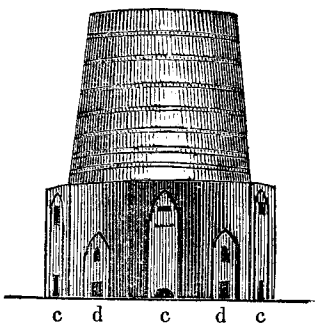
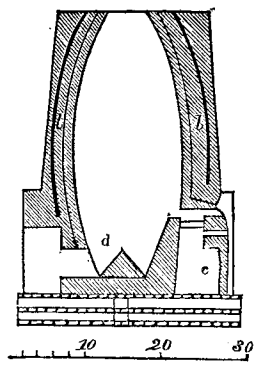
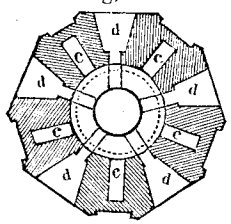


Fig. 3.



Fig, 4.



EXPLANATIONS.—Figure 2 represents a perpetual kiln, which is used in Belgium; figure 3 is a vertical section of it, and figure 4 is a ground plan. *d, d, d, d, d,* are openings for withdrawing the lime; *c, c, c, c, c,* are the furnaces, whose connection with the interior is shewn in the vertical section, which passes through one furnace and the opposite opening for withdrawing the lime; *b, b,* is a space filled with ashes: the outside is rough stone.

Primary Limestones.

Mica Slate Limestone.—This is a greyish blue siliceous limestone, with a brown, gritty, earthy surface where weathered. It is abundantly interstratified with the strata of the mica slate and argillaceous slate formations. These formations occupy most of the eastern part of the State, viz: all that part which lies east of the talcose slate formation. Their western boundary, so far as I have observed it, is as follows; beginning at the north, in the east part of Craftsbury, I have traced it in a direct line to Montpelier, a mile east of the village: it runs east of Berlin and Northfield, between Bethel and Royalton, through the west part of Barnard, between Bridgewater and Woodstock, through the west part of Reading, to the south of which it leaves only the river towns on the east. I have seen this limestone in the following towns, in most of them abundantly; viz: Vernon, Guilford, Brattleboro, Dummerston, Weathersfield, Reading, Woodstock, Barnard, Norwich, Sharon, Royalton, Strafford, Montpelier, Calais, Monroe, Hardwick, and Greensboro, and have heard of it in many others. It will probably be found in most if not all of the towns east of the line indicated, which undoubtedly extends in the same northerly direction into Canada.

I am not aware that lime has been made from this rock in any towns in the southern half of the State, except in BARNARD, where, at the suggestion of Dr. Fay of Stockbridge, attempts have been made, some of which have been successful. It is found to yield a very strong lime. We have above remarked on the difficulty of burning it.

In the geological survey of Massachusetts, the same limestone was discovered in some of the towns west of the Connecticut river, and has since been extensively used, chiefly for agricultural purposes. In this State, the use of it will probably be of great advantage to agriculture. If the geological survey should be the means of bringing it into general use, it will, in this item alone, return to the State ten-fold the amount of its expense. It is to be hoped that occasional failures in burning it, arising at first from want of the experience before shewn to be necessary, may not discourage any without thorough trial.

In WEATHERSFIELD is a pure white limestone, much used, whose geological position needs farther examination. It is within the limits of the mica slate formation.

In the west part of WHITTINGHAM are patches of white limestone, which is of great importance to that portion of the State. Unfortunately its utility is much circumscribed by the bad roads in its vicinity.

Talcose Slate Limestone. Occasional patches of nearly or quite pure white granular limestone occur in the primary talcose slate, as in PLYMOUTH and the south part of BRIDGEWATER, where it is burned in large quantities. The Moretown bed of white limestone, mentioned on page 41, is in this formation.

T. W. Strong, Esq., of Rutland, informed us that on the top of the Green Mountains, in the south part of Stockbridge, is an extensive ledge of white limestone. It is probably associated with talcose slate.

Taconic Limestones.

These limestones constitute a large portion of the Taconic system, which occupies most of the State west of the Green Mountains. They alternate with argillaceous and talcose slates, the latter of which, north of Addison Co., appears to take the place of the limestones for the most part. After what has been said of the marbles of this system, little need be added in this report. The most compact varieties are preferred for making lime. It will of course be important to ascertain which of these limestones are magnesian, that in the selection reference may be had to the use to be made of the lime. Nearly every town in this extensive district contains inexhaustible quantities of stone suitable for making the best fat lime.

Champlain Limestone.

The characters of these limestones have been sufficiently described. The towns, which border on Lake Champlain, contain inexhaustible supplies of compact and shell limestone, which makes a very fat lime.

MARL.

Marl is a pulverulent carbonate of lime, more or less mixed with clay, and often resulting from the disintegration of myriads of small shells, which, in the lapse of ages, have accumulated in deposits many feet in thickness. The name has sometimes been extended to other pulverulent deposits.

Owing to the fineness of the particles, marl may be used in the same manner as lime for agricultural purposes. Supposing, as in the case of lime, it has been ascertained that it is wanted in a given soil, the quantity required will of course depend on the quantity of clay in the marl. It is obvious also that marls abounding with clay will be *more* beneficial to light than to stiff soils, since it will serve both as a corrective and a fertilizer. Much of the brown clay west of the Green Mountains is more or less marly, and may therefore be applied with the greater advantage to sandy soils. On the other hand, many beds of marl are nearly pure carbonate of lime, and equally useful for clayey soils, which are deficient in lime.

The northern part of the State has been found, by Messrs. Thompson and Hall, to abound in marl-beds, which are destined to be a source of wealth to the farming interest for ages to come.

MUCK.

This term is very generally applied through this State to those deposits of vegetable matter in swampy grounds, which may enrich the lands of the practical farmer, but have furnished only 'a bone of contention' to some agricultural chemists. Indisposed to enlist in the war among geine, humus, and humic, crenic, and apocrenic acids, we merely allude to this important subject, for the purpose of calling to it the attention of an agricultural community, and shall not even suggest at present a more correct name than *muck*.

We have not yet seen a bed of genuine *peat*, and even the sphagnous swamp, in the top of Snake Mountain in WEYBRIDGE, consists only of a thin, half-liquid, light brown, slimy mass, which has been penetrated by poles twenty or thirty feet, without reaching the bottom. But deposits of vegetable matter suitable for agricultural purposes are common, frequently overlying beds of marl. Many of them have been examined by Messrs. Hall and Thompson.

If these substances are used without mixture in their natural state, the effect may disappoint the farmer, since, from their slow decay, the fertilizing influence will be proportionally slow. Peat is often acid, and will be injurious, unless the acid is neutralized by lime. If muck be mixed with half its weight of barn-yard manure, and the heap be covered with a layer of muck to prevent the escape of volatile substances, the whole will be as valuable as so much unmixed barn-yard manure. After the fermentation has gone on sufficiently, lime, or marl from the beds which often accompany the muck, may be added to advantage.

MATERIALS FOR POTTERY AND PORCELAIN.

Common clay, suitable for the manufacture of bricks and of coarse earthen ware, is so generally distributed, that a particular description is unnecessary in this report. Some of our clays contain carbonate of lime, which, being converted into quicklime in burning, afterwards slacks, and the bricks crumble. It may easily

be detected by the effervescence when a piece of marly clay is placed in vinegar or dilute oil of vitriol.

Kaolin is known in some parts of the State as 'white clay,' 'putty,' &c., the beds being often called 'putty-beds.' It is of great value in the manufacture of fire-bricks, stone-ware, the best kinds of pottery, and fine porcelain. It occurs in Bennington, East Dorset, South Wallingford, Rutland, Chittenden, Brandon, and Monkton.

Bennington.—Half a mile north-east of the east village is a deposit of excellent kaolin, which supplies the manufactory of Norton & Fenton in the village. This bed is overlaid by drift, but the state of the excavation did not admit of an examination of its structure. Mr. F. very obligingly shewed us the material, and the ware in various stages of process, and gave the desired information with illustrative specimens. With a public spirit more praiseworthy than common, Mr. F. freely communicates the valuable results of his experience.

For fire-bricks, the kaolin is made into paste with water, from which bricks are formed and burnt. These bricks, retaining the whiteness of the kaolin, and becoming very hard, are called 'clay bricks.' They are next broken up by a mill and sifted, so as to be of the coarseness of fine gravel. This is mixed with unburnt kaolin and arenaceous quartz, pressed in moulds of the required form and size and burnt in the same manner as before. These fire-bricks are very white and hard, and when fractured shew their composition of broken clay-brick and kaolin.

Other kinds of pottery are here manufactured, and a great variety of articles of stone-ware. The latter was made with a mixture of kaolin and arenaceous quartz. But since our visit, improvements have been made, both in the construction of the works and in the processes, and I therefore take the liberty of inserting the following letter from Mr. F.

Bennington, September 15, 1845.

Dear Sir,—Your favor of the 5th instant came in due course, for which you will please accept my thanks. You have probably noticed by the papers the loss of our works by fire, which will be, I trust, a sufficient apology for me, for not furnishing you with some facts in relation to our business, as I had intended to do. The re-building of our works has occupied my whole attention since the fire, and has suspended all my experiments in the manufacture of porcelain, to an indefinite period. We are now erecting, under the firm of Norton & Fenton, the most extensive and best constructed pottery works in this country. The buildings are fire-proof, in form a hollow-square, 114 feet by 92. We intend to have a plan of our works taken when completed, of which we will furnish a copy if you should wish. Our works are constructed so as to use more of our own materials than formerly. We are building mills for refining the kaolin, and also for pulverizing and grinding the faldspar stone, which we showed you a sample of, a mixture of feldspar, silex, &c. My experiments have proved it to be a very valuable article for common stone-ware, especially for chemical and other important purposes. By uniting these materials in certain proportions, we produce a much better, handsomer, and stronger stone-ware than is made in this country. The other improvements which we have made, consist in the construction of our kilns, for which we are entitled to patent, but shall not ask it, having furnished models to the owners of nearly all the principal potteries in the Northern States, who have built, or are intending to build, upon our plan. We have also perfected a system of firing our kilns, different from any other. In short, we have reduced it to a perfect system, while others make it an uncertain guess-work. These improvements render our wares more durable and perfect, and give us the preference wherever we send our goods. The character of our fire-bricks is also well known. They are a composition of materials which we find here, consisting of arenaceous quartz and kaolin. Being very pure, they make a good fire-brick, which will stand longer in a strong heat than any other brick known. They are used for blast furnace hearths, and, in many places, where no other fire-bricks will endure. The amount of fire-bricks and pottery-ware which we manufacture yearly, will not vary much from $20,000. I intend to continue my experiments as soon as I have leisure, with materials found here, of which I will endeavor to keep you advised.

I remain your friend and ob't serv't, C. W. FENTON.

In East Dorset, Wallingford, Chittenden, and Brandon, kaolin is associated with the brown iron ore-beds, as before described. In Wallingford and Chittenden, we have seen it interstratified with the layers of brown and red clayey ochres, which are conformable with the limestone strata; or rather, these unconsolidated layers are more correctly described as all of them consisting of clay—some being colored with ochre, more or less, so as to present no marked line of distinction between the ochreous and the pure clay. Hence the same theory, which has been suggested (p. 29) of the origin of the ore-beds, must account for these layers of clay. This theory of the decomposition of an argillaceous limestone, causing the carbonate of lime to be carried off by the percolation of water while the clay is left in undisturbed strata, receives farther confirmation in the limestone rock, before mentioned (p. 22) as overlying the Bristol ore-bed, in which the process has been arrested when half completed. This rock is porous, very argillaceous, soft when wet and hard when well dried, and appears to differ from the argillaceous limestone which is usually associated with brown iron ore, only in the loss of much of the carbonate of lime.

Monkton.—Half a mile north of the brown iron ore-bed, is 'the putty-bed' of Mr. Safford Tracy. In the Literary and Philosophical Repertory, published in Middlebury, 1813–1815, is a very particular account of this bed, which is described as resulting from the decomposition of graphic granite, which the writer saw in various stages of disintegration from the solid rock to the kaolin. I regret being unable to verify this description, probably because the state of the excavation afforded the author of that article a better opportunity of examination than can be had at present. Owing to the falling in of the excavation, I was unable to

determine the position of the bed, farther than that it was under drift; and in the absence of Mr. T., I was unable to obtain any information of its structure as seen previously.

This bed of kaolin is probably very extensive. A mixture of drift and kaolin, near the ore-bed, half a mile south, may have been derived from this source. Two years since, forty tons were taken from this bed and sold in Burlington at $40.00 per ton. It was used for pottery, lining furnace pots, &c. In the iron furnace in Middlebury, it has been used for lining the ladles and repairing the furnace lining.

Besides kaolin, flints are used in the manufacture of fine porcelain. The paste, called 'slip,' is made with a mixture of five or six parts of prepared kaolin with one part of the finest particles of pulverized flints. Perhaps the best substitute which we have for flints would be the glassy hyaline quartz rock, before mentioned (p. 22) as constituting ranges of hills in the north-west part of Bristol and in Monkton.

Of *arenaceous quartz*, which enters largely into the composition of stone-ware, I shall speak under the head of

MATERIALS FOR GLASS.

Arenaceous or sandy quartz is a variety which is composed of grains so loosely coherent, that the stone can be easily pounded into sand. Some varieties crumble between the fingers, and others require hammering. In a stamping machine, such as is used at forges, arenaceous quartz is easily reduced to fine sand suitable for making glass, of which it is the largest ingredient. The other essential ingredient must be an alkali, capable of uniting chemically with the quartz sand at a high temperature. Impure soda or potash is commonly used, with more or less lime. At Burlington we were informed that lime was used in large proportion. The presence of a little iron in the materials is very common, and gives the glass a green tinge, which may be removed by a small proportion of manganese ore. A little excess of manganese gives the glass a violet tinge. For flint glass, red lead is added, which renders the glass very clear and brilliant, as well as softer and more fusible.

Vernon.—Near the west line of this town, associated with gneiss, is a ledge of arenaceous quartz rock, belonging to Mr. Hubbard. The strata have a direction of north and south, with a dip of 26° to the east, which facilitates the working of the stone, as it is on the east side of a hill. There are two varieties; one is of a pure, snow-white saccharoid, and so friable that it cannot be handled without crumbling, with some stains of iron rust. The other is less saccharoid, and less friable, and more stained with iron rust. The ledge is quarried to some extent for the glass works in Keene, N. H.

Bennington.—By the politeness of Mr. Fenton, we were furnished with specimens of the very friable white arenaceous quartz, which is used in the composition of stone-ware, and which is found in the east part of this town. We were unable to visit the locality, but on ascending the mountains east of Bennington, we observed bowlders of the same variety.

Wallingford.—In one of the lateral adits of the Wallingford iron mine, before mentioned (p. 19), arenaceous quartz rock was reached, and a quantity had been removed. The stone was not known there to be of any value, but it has precisely the same characters with the stone found in

Pittsford, near the north line of the town, within a few rods of the main road from Pittsford to Brandon. It is overlaid by a mass of drift, in which are angular fragments of the same, and which is cut through by a rivulet, that revealed the quartz. The glass works in Salisbury obtained their stone from this locality, which has not been used since the suspension of these works.

The arenaceous quartz of Pittsford and Wallingford is remarkable for the minute, opaque, snow-white grains of a mineral, which may be decomposed feldspar, thickly disseminated through the rock,—and also for the transparency of a portion of the minute grains of quartz, giving it a very peculiar and beautiful appearance. May not the arenaceous structure of the rock be due to the decomposition of the feldspar?

In Bennington, Wallingford, and Pittsford, this mineral occurs in immediate proximity to the common granular quartz of the Taconic system.

Huntington.—On the Green Mountains east of the south village, we were informed, is a ledge of rock mostly greyish, with white veins, which the specimens shewn us proved to be a very friable arenaceous quartz rock, probably with the greyish parts micaceous. Whether it be sufficiently pure for glass, is uncertain.

COPPERAS ORE.

This mineral, called by the mineralogist *iron pyrites*, we have before noticed (p. 31). It is a compound of sulphur and iron, but of no value as an ore of iron. Although very extensively disseminated, it is so often mistaken for gold, as to have attained the name of *fools' gold*. On account of the low price of copperas in the market, ($30 per ton,) and the comparatively expensive process of manufacture, the ore must be found in great quantity, and in a very favorable situation, to be of any value. It is extremely improbable that any works will compete with those of

STRAFFORD.—In our visit to the copperas works, we were much indebted to the polite attentions of Mr. Reynolds, the agent. The vein is in the south-east part of the town, on the east side and near the summit of Copperas Hill. It has a direction of north 10° west, is nearly perpendicular, of unknown length and depth, and is *four rods wide!* This extraordinary vein, which is not known to have its equal in the world, consists of nearly pure ore, in some parts with siliceous grains, copper pyrites (v. p. 30), fasciculite, and acicular brown tourmaline.

Not only the inexhaustible quantity and purity of the ore, but its situation also give unusual facilities for the manufacture of the copperas. The vein is worked to the open air—large blocks of ore being blasted out, and then with sledges broken to the size of an egg. These fragments are then removed a little down hill, and formed into an immense conical heap, in which air and moisture sustain a smothered combustion, which has been only commenced by wood fuel, and which, if not checked by an excess of water, would be sufficient to to drive off the sulphur, and to vitrify the mass. In this process, the water flows from a higher level to the top of the heap, and the only inconvenience attending the manufacture is the limited supply of water in dry weather. In this process, by the oxygen of the air, the sulphur is converted into sulphuric acid (oil of vitriol), and the iron into oxide of iron, which, combining together, constitute copperas. This, being soluble in water, is leached out by the stream of water, and the ley runs down into a vat, in which it is concentrated. It is then drawn down into other vats for crystallization. Stalactites of copperas are seen pendant from the troughs, and, with the exception of the green tinge, exactly resemble icicles—a singular spectacle in the heat of summer.

A part of the copperas is sent to Whitehall, but most of it is sent to Boston at an expense for freight of $8.00 per ton—a heavy drawback on the low price of the article. Last year 1600 tons were sent to market. It is chiefly used for black dyes, ink, &c., and "nearly every man, who wears a black hat, or black cloth of American manufacture, is a patron of these works. * * * In case of war, this mine would prove of great value to the country; for any desired quantity of sulphur may be obtained by distilling the iron pyrites. At the present price of sulphur, it is not worth the expense of its separation, and is much better employed in forming copperas." Dr. Jackson's Report on the Geology of New Hampshire.

SHREWSBURY.—The works in this town belong to the same company, who own those of Strafford. On account of the superior advantages of the latter, the company have abandoned the Shrewsbury works.

CORINTH.—In this town is a vein of iron pyrites, which I have not yet examined, but which is supposed to be a continuation of the Strafford vein. It is on land of Mr. Ira Towle.

Many other towns might be named as containing this ore, but as they cannot enter into competition with Strafford, we have deemed it unnecessary to give them particular attention, or to describe them in this report. Some of them are of scientific interest, as affording secondary forms of crystals, which are far less common than the primary cubic form. We have a twin regular octahedral crystal from the east part of Middlebury, and a cube with truncated angles from Sherburne.

BUILDING STONES.

Besides the marble, which we have already noticed as a building stone, the most important are granite and gneiss, quartz rock, and the red sand-rock.

A much interrupted range of *granite* extends through the east part of the State, appearing in Craftsbury, Barre, Dummerston, and other towns. Much which is called granite is gneiss with the stratification more or less obliterated by partial fusion. An example of such altered gneiss may be seen in Chester. The difference between these two rocks, the granite being unstratified and the gneiss stratified, is of some economical importance, since, as a consequence, gneiss is most easily got out in large tables, while granite may be split into pieces of any required thickness. Often, however, seams of an origin very different from stratification, perhaps of concretion, divide granite and facilitate the quarrying of the rock: but these seams do not usually divide it into layers as thin as the strata or gneiss.

For some details of localities, the report of Messrs. Hall and Thompson may be consulted.

The *quartz rock*, which constitutes the western base of the Green Mountains from the north part of Addison county to Massachusetts, is sometimes found sufficiently stratified to admit of being worked with facility, and in some cases other planes of division present good natural faces.

In the east part of BRANDON, very large tables are got out, consisting of strata six or eight inches thick. Some of them have been used in the construction of the cells in the new jail of Addison county, each stone constituting the side of a cell, which would defy the ingenuity and perseverance of a Baron Trenck to break through.

In the east part of BRISTOL, at the second bridge east from the village, a branch of the New Haven river has exposed a remarkably even-bedded quartz rock. The strata have a direction of

north 30° west, and an easterly dip of only 18°. They are from two to eight inches thick, and have a rippled and blotched surface, which may easily be dressed. Small grains of iron pyrites, disseminated through the rock, are not sufficient to impair its strength, but may produce some iron stains. Blocks of any desired superficies may here be obtained.

The *red sand-rock* of the Champlain Division (grey sandstone of the New York Geologists,) is a good building stone. Willard's quarry, in the south part of the village of BURLINGTON, furnishes the large quantities which are demanded by the vigorous growth of that town. This stone is composed mostly of quartz, colored with peroxide of iron, and is exceedingly hard. In weathering, it gives up a portion of its coloring ingredient, and becomes greyish, but without injuring its appearance. It is mostly used for under-pinning, and also as a flagging stone.

This quarry is of great scientific interest, affording one of the best exhibitions which we have of this formation. Different strata contain several remarkable fucoids, in great abundance, and some impressions, much resembling the tracks of animals, but so anomalous that, in the want of a succession of tracks in the few rather crowded impressions found, we are apprehensive lest the subject should remain in obscurity.

SNAKE MOUNTAIN, which lies in parts of several towns in the west part of Addison County, is composed, its upper and east parts, of the same rock. In many places it may furnish a good building stone, with smooth natural faces, produced by the jointed structure. A few houses have been constructed of it, and we may mention that of Mr. J. Childs, on the east side of the mountain, as a substantial example. If the walls are placed on good foundations, and are of a proper thickness, they who build with this stone may have the satisfaction of knowing that they are building for a distant posterity.

MINERAL SPRINGS.

Mineral Springs, of more or less virtue, are common, but at present we can notice only the two most important of those which we have seen.

ALBURGH.—About five miles north-north-east from the village, is the Spring, which has been much frequented by the neighboring inhabitants. It rises from an argillo-calcareous slate, and is very strongly impregnated with hydro-sulphuric acid gas. A large house has been erected for the accommodation of visitors, but is not occupied at present.

HIGHGATE.—Highgate Springs are within twelve miles of the steamboat landing at St. Albans Bay, with which there is a daily

communication by stage. The water rises from slaty rocks of the Champlain Division, and is very strongly impregnated with hydro-sulphuric acid gas, but is perfectly limpid. The gentlemanly proprietor, Mr. H. N. Cole, to whom we were much indebted for his polite attentions and aid in the object of our visit, keeps an excellent house, which, with its neat and beautiful grounds, presents many attractions.

SCENERY.

It may be asked, what has Economical Geology to do with the grand and beautiful scenery of Vermont? The lovers of fine scenery may protest against the sacrilege, which we are about to commit, but Jonathan is well known to be as fond of money as of the sublime, and, as his servant, we are bound to consult his *interest*. We do then affirm that our magnificent scenery may be made a source of pecuniary profit; not that it can be boxed up, and sent on rail-road cars to a market, nor that the cool and invigorating mountain air of summer, can be bottled up like "congress water," and retailed to distant valetudinarians. But if by descriptions of some of the most interesting features of our scenery, amply illustrated by *good* engravings, we can make our scenery better known, travellers from abroad will more frequent our State, give us the pleasure of their society, and to our landlords that of receiving their money. We doubt not that they will consider themselves well paid, (we really think they will have the best of the bargain), in restored health and in those pictures which nature can paint on the mind's eye, as no artist can put on canvas.

DISTRIBUTION OF MINERAL WEALTH.

In the distribution of mineral *substances most important to agriculture*, as limestone of various qualities and marl, we have seen, in the foregoing pages, that nature has supplied nearly all parts of the State with an impartial hand. But, as is frequently the case in other parts of the world, the mineral wealth (using this phrase in its ordinary acceptation) is greatly accumulated within certain narrow limits. We have had frequent occasion to mention such a region, as extending through from the north part of Addison county to the south line of the State, and which is prolonged through Massachusetts and other States. Probably however the richest part of this range is in Vermont, where are closely associated the vast deposits of white and blue marble, of brown iron ore and manganese ore, of ochres and kaolin, and the arenaceous quartz.

In Plymouth we find another but more limited mineral district, rich in iron ores, marble, and lime.

These are the principal districts in which several important sources of mineral wealth are combined. Other parts are more or less richly furnished with a less number, as Grand Isle county with its marble, Strafford with Copperas ore, and other places which have been described.

In all parts there is abundant encouragement for a judicious attention to those sources of wealth, which Geology developes. If rich ores and elegant marbles do not exist in every town, there is the greater necessity of seeking the other less attractive, but, to our great agricultural interest, not less important treasures of lime, marl, and vegetable deposits, which, like other common bounties of Divine Providence, are the more widely disseminated in proportion as they are more generally needed.

SCIENTIFIC GEOLOGY.

Overtaken here by the last of the few days assigned to the preparation of this report, we are strictly limited to our plan of confining it almost exclusively to the topics, which are of economical interest. We can only subjoin a list of the principal formations of stratified rocks and of the igneous rocks. The former we shall enumerate in the order of their superposition, so far as it has been ascertained. The geologist will perceive in the list an extraordinary gap, the entire series from the drift to the lowest division of the New-York system being wanting.

Superficial Deposits.

1. Fluviatile and other modern deposits.
2. Gravel and coarse sand.
3. Fine sand.
4. Brown clay; with littoral shells now existing on the coast of New England.
5. Blue clay; with pelagic shells, either now existing on the coast of New England, or their extinct analogues.
6. Drift.

Tertiary groups wanting.

Secondary groups wanting. The New Red Sandstone of Massachusetts terminates within five miles of the State line.

New-York System.

Three upper divisions wanting.
Fourth division, *Champlain group.*

1. Red sandrock.
2. Hudson river shales.
3. Utica slate.
4. Trenton limestone.
5. Chazy limestone.
6. Calciferous sandstone.

The Potsdam sandstone is within half a mile of the state line at Whitehall.

Taconic System.

1. Roofing slate.
2. Taconic slate.
3. Sparry limestone.
4. Magnesian slates.
5. Stockbridge limestone.
6. Granular quartz rock.

All these have an inverted dip.

The Taconic slates alternate with beds of sparry limestone, one of which in Benson is fossiliferous.

The Magnesian slates alternate with the Stockbridge limestone, which appears north of Addison county only in limited patches, and the Magnesian slates take its place on a great scale as far as Canada, and are with difficulty separated from the primary Talcose slates.

The Quartz rock accompanies the Stockbridge limestone, disappearing with it in the north part of Addison county. It alternates with the mica slate of the west ridge of the Green Mountains, and will render it more difficult to separate the Taconic from the Primary than from the New-York system. Yet a bowlder—referred to this rock, from its situation, on the shore of Lake Dunmore between mountains of quartz rock, as well as from its lithological characters, being much more compact than Potsdam sandstone,—contains two remarkable species of polyparia, (?) one of them with numerous specimens. This fact will explain an allusion in the letter of President Hitchcock in the appendix.

Primary System.

1. Argillaceous slate.
2. Calcareo-mica slate.
3. Mica slate.
4. Talcose slate.
5. Green Mountain gneiss.
6. Gneiss proper.

Nos. 1 and 2 constitute most of the eastern portion of the state, and are interstratified, the latter often very abundantly, with the greyish blue siliceous limestone before-mentioned (p. 49).

No. 3 occupies more or less of the west ridge of the Green Mountains, next to the Taconic System, and is not very broad.

No. 4 occupies the space between Nos 2 and 3 to the north of Mount Holly, in and south of which town its place is more or less occupied by No. 5. Hornblendic and Chloritic rocks occur as subordinate beds in the range of Nos. 4 and 5.

No. 6 comes into the south east margin of the state at Bellows Falls; it also occurs in Whitingham.

The above is not offered as shewing the order of superposition of the primary strata, which are involved in great confusion. The order of succession is traced with great difficulty; litholo-gical characters are of little use; and fossils of course are wanting.

Serpentine is claimed by the unstratified rocks, but very indistinct traces of stratification lend some support to the theory that it is an aqueous rock altered by fusion. It lies in the talcose slate formation.

The *unstratified rocks* are granite, before-mentioned, (p. 57), and greenstone, which has yet been seen only in dykes.

APPENDIX.

Bill Providing for a Geological Survey of Vermont.

It is hereby enacted by the General Assembly of the State of Vermont, as follows:—

§ 1. The Governor is hereby authorized and directed to appoint a State Geologist, who shall have a competent knowledge of scientific and practical geology and mineralogy, and shall be subject to the orders of the governor for the time being, and removed at his pleasure.

§ 2. The state geologist, with the approbation of the governor, shall, from time to time, appoint all proper and necessary assistants, fix their compensations, direct them in their labors, and remove them and appoint others whenever it shall be found necessary or expedient.

§ 3. It shall be the duty of the state geologist, as soon as practicable, to commence and prosecute a thorough geological survey of the state, embracing therein a full and scientific examination and description of its rocks, soils, metals and minerals; make careful and complete assays and analyses of the same, and annually, on or before the first day of October, to report to the governor the progress of the work, the most efficient and economical manner of conducting it, and an estimate of the expense for the ensuing year.

§ 4. For the purpose of carrying into effect the provisions of this act, the sum of two thousand dollars annually, for the term of three years, is hereby appropriated.

§ 5. All claims under the provisions of this act shall be presented to the auditor of accounts for allowance, who shall draw orders on the treasurer of the state, for the amount he shall find due, equal to, but not exceeding in any year, the annual appropriation.

Approved, Oct. 28, 1844.

Letter from President Hitchcock.

AMHERST, Mass., Sept. 30, 1845.

DEAR SIR—The recent tour of some 400 miles, which I made in your company in Vermont, has left so pleasant recollections on my mind, that I readily comply with your request to give you the prominent impressions made upon me, respecting the geology of that State. Details I shall not of course undertake to give; since that will be fully done by yourself; and it will be mainly the economical geology to which I shall confine my attention.

I ought to say, that my opinion is not based entirely upon the observations made during this tour. For I have long had my eye upon Vermont; and have, in years past, gone over some portions of it in various directions. And I have always had a very favorable opinion of its mineral wealth.

In estimating the economical value of rocks and minerals, three inquiries are of great importance: First, Are the rocks and minerals of such a kind as will always be in demand, and will the demand increase with the population of the country? Secondly, Are the deposits likely to be exhausted? Thirdly, Are there facilities of transportation to markets?

Now I think we can answer the first question decidedly in the affirmative. There is, first, *granite:* and who can doubt but such a fine rock for architectural purposes as occurs in Windham and Orleans counties, will be increasingly sought after, as wealth and population increase? The beautiful *soapstone*, too, that occurs in so many beds, on a line extending from Whitingham to Troy on Canada line, will never want for a market, if the proposed rail-road shall be constructed. The vast ranges of *limestone* and *marble*, which occupy so much of the surface on the west side of the Green Mountains, through the whole length of the State,—already extensively used,—must more and more attract the attention of capitalists and the citizens of our large cities. I have examined the same range of limestone in Massachusetts, Connecticut, and New York, in numerous places; but I must confess that I have never met with such beautiful marble anywhere else, as in some of the towns of Vermont—as Brandon, Pittsford, and West Rutland. I cannot see why some of the quarries there, (and it appeared to me that fifty other quarries as good might be opened in the same hills,) would not furnish an excellent material for statuary, and in blocks large enough for any purpose. Then you know Plymouth furnishes a beautiful marble; but I have not visited the spot. I suspect, that there is a bed, or probably several beds, of dolomitic limestone, extending from Whitingham through Somerset, Cavendish, Plymouth, &c, nearly or quite to Canada; and in the deficiency of limestone east of the Green Mountains, this

must be of great value for making quicklime—since the presence of magnesia does not, as I can learn, injure lime for mortar.

Similar remarks may be made respecting the great number of beds of hematite iron ore and manganese accompanying the limestone west of the mountains—to say nothing of the fine deposits of specular and magnetic oxide, which you have discovered in the northern part of the State. Who can doubt that the demand for such valuable ores will increase as long as society and civilization do? And so of the porcelain clay of Bennington, Monkton, &c. The arenaceous quartz, often occurring in the vicinity of the clay, must much increase the value of the latter for making fire-bricks. Indeed, I think Vermont must be the chief dependence of the New England States for this clay. So too, I apprehend that no other known place in New England can compete with Strafford and Shrewsbury in the manufacture of copperas.

Accompanying the talcose slate, on the east side of the mountains, as you know, we find vast beds of *serpentine*, some of which is very elegant. And although this ornamental stone has not yet excited the interest which its beauty and durability deserve, it cannot be doubted that taste and wealth will ere long demand it in abundance.

In passing from Chester to Grafton, (not in your company,) I noticed mica slate, which appeared to me capable of furnishing *flagging stones* as fine as the famous Bolton stone of Connecticut which is met with extensively in all our Atlantic cities and large towns.

It should be borne in mind, that, with the exception of granite, the above rocks and minerals are very sparingly found east of Connecticut river; so that when the contemplated rail-roads are completed, there must be a demand for them in that direction. I should hope, also, that ere many years, the quicklime and the marl which you have found in so many towns, might be transported into regions destitute of the carbonate of lime, after farmers shall have learnt their value. But it cannot be done until the people of Vermont shall construct *perpetual kilns* for burning their lime, and thus reducing its price; for I saw not one kiln of this description, although they may exist.

I have already virtually replied to the second question, whether the economically valuable rocks and minerals of the State above named—and I might have added to the list—are likely to be exhausted. In regard to most of them, we might as reasonably expect that the Green Mountains will be dug away. Some may fear for the deposits of iron, since they are generally regarded as superficial. But after examining most of these beds between Canada and the Highlands on Hudson river, I have come to the conclusion, that most of them are connected with the limestone, or

mica or talcose slates beneath; in other words, that they extend into those rocks downwards either as beds or veins. If they do, they will never be exhausted, if the miner can only find the bed,—a work of difficulty, because the upper part has been often torn off and scattered around by some powerful denuding agency. I hope some proprietor of these ore-beds will try to settle this question, as it is of so much practical importance.

Ledges of granite, suitable for architectural purposes, are not numerous in Vermont, as above remarked. The northern one I have not visited; but in Dummerston, Black Mountain is mostly composed of a beautiful variety, and enough in quantity to supply all New England thousands of years. Nor can I doubt but when a rail-road is completed along Connecticut river, this fine rock will not remain almost entirely neglected, as it now is. Then, too, the fine slate-quarries in the same town and in Guilford, will be more extensively explored than they now are.

The third question asks whether there are facilities for transporting these mineral treasures to market? On the west, Lake Champlain gives an outlet for the marble, iron, &c., west of the mountains; but on the east side at present, it must be acknowledged that the markets are distant and difficult to be reached. But it is well known that one or two rail-roads at least are certain of being constructed shortly. It is not for me to express an opinion as to which of the proposed routes diagonally through the State is the best; but I will say, either of them will give access to most important mineral districts.

The objects of scientific interest in the geology of Vermont, are certainly very numerous; and I doubt not but the survey will bring out many things of value to the science. You are aware that almost the whole of Vermont is disputed ground in respect to some problems of sublime interest: for it is surely a sublime question, whether the almost entire ranges of the Green and Appalachian Mountains have been folded together like the crumpling of paper, and then thrown over. Perhaps you can solve this problem by a careful study of the rocks of Vermont. But I would not anticipate too much, nor blame you if such a solution should not be in your power. At any rate, I shall hope that the facts brought out by you will throw some light on these great and complicated questions. It ought not to be forgotten, that most of the rocks of Vermont have that intermediate character, which has ever been most perplexing to geologists; and hence I trust that the enlightened men who direct the survey, will not hurry you to a decision respecting them, till you have had time for very careful examination.

Another point of great interest in scientific geology, is the phenomena of drift; and I have seen enough in Vermont of these

phenomena, to satisfy myself that you will be able to present some very interesting facts on this subject.

Upon the whole, I trust the final result of this survey will show that Vermont is not surpassed by any State of the Union in its economical and scientific geology, with the exception, perhaps, of coal and salt, which I cannot hope will be found within its limits.

I confess I did not expect to see so deep an interest manifested in geology and in this survey by the citizens of the State. It certainly indicates a high degree of intelligence and just appreciation of scientific pursuits; and I am bold to say, that a parallel example cannot be found in any State of the Union. I am not without fears, however, that this interest, while in some respects it will greatly facilitate your labors, and render them pleasant, may somewhat embarrass you. I fear it will be expected, and almost claimed, that you should spend so much time in each town, that three years will find your work unfinished. Even intelligent people are not always aware, how necessary it is for the geologist, who is working out intricate problems respecting the rocks, *to follow the leadings of the rocks, rather than of the inhabitants.*

I apprehend, also, that some may be disappointed if you do not discover many new and very valuable substances. Now I doubt not you will make some such discoveries, as you have already done. But this is not, in my opinion, the chief use of a survey. Its more important benefits are, in examining, describing, and arranging, the substances already known, or partially known; settling the characters of the rocks, so as to show what may and what may not be expected in them, and thus preventing useless expenditures; in making suggestions as to the use of substances now perhaps partially used; and in awaking men all over the State to be looking out for new things.

I should not think it strange if some should be disappointed, as they have been in other States, by anticipatiug too much from the mere analyses of soils. The impression is very strong, through the community, that the chemist, by such an analysis, can determine what is wanting to render a soil fertile, or what renders it barren. Now even admitting that he could do this, an analysis of the soil from almost every farm in the state, nay, from almost every field, would be necessary to make it of much value; and it is not generally known that every such analysis, accurate enough for this purpose, could not consume less than two or three weeks. But I do not believe that agricultural chemistry is yet advanced enough to enable the chemist to say in many cases what ingredient added will be sure to render a barren soil prolific; although it is more easy to detect hurtful ingredients. But

the analysis of some of the prevailing soils of the State, (for example, those from the limestone, mica slate, gneiss, and argillaceous slate regions,) will enable you to make suggestions that may be of great use. But I hope you will not be pressed to give your results on this subject very soon.

I was glad to be introduced to your assistants, and to find that you are aided by men so well acquainted with the subject, so trustworthy, and so persevering.

Upon the whole, allow me to say, that I am highly gratified with the present aspects and prospects of the survey: and if nothing adverse occurs, I cannot but anticipate that the final result will be highly useful and creditable to the State, and honorable to yourself.

Most truly and sincerely, yours,

EDWARD HITCHCOCK.

Report of Messrs. Hall and Thompson.

To C. B. ADAMS, State Geologist:

SIR,—Having been commissioned by yourself to assist in making a Geological Survey of the State of Vermont, we commenced our field labors in the early part of May, and have continued them with but slight interruptions to the present time. During this period we have visited all the towns, (with the exception of a few in the unsettled parts of Essex county) in the counties of Grand Isle, Franklin, Orleans, Lamoille, Chittenden, Washington, Caledonia and Essex, and also a part of the towns in Orange county. While thus engaged we have kept daily journals of our doings, in which we have noted the kind, the direction and the dip of the different ranges of rocks, the direction of the drift-scratches upon their surfaces, together with localities, of muck, peat and shell-marl, and of ores and other interesting minerals,—which journals are herewith submitted. We have also collected specimens of all the rocks, fossils and minerals and forwarded them to the general depot. But in addition to those minute particulars, we deem it suitable to offer a few general remarks respecting that portion of the state to which our labors have been confined.

The *rocks*, which form the basis of the county of Grand Isle, are the Chazy limestone, Trenton limestone, black marble and black slate, the latter being almost the only rock, in place, in Alburgh, North Hero, and the eastern parts of the townships of Grand Isle und South Hero. It also constitutes Juniper Island and most of the other small islands in this part of the lake, and is

seen on the east shore of the Isle La Motte passing under the Trenton limestone. This slate is, in many places, filled with sulphuret of iron, and with seams of calcareous spar and quartz, the two latter often beautifully crystalized. On the Isle La Motte the limestone and marble are extensively quarried for the New-York and other markets and for the manufacture of quicklime; but as this county has been visited by yourself, we deem it unnecessary to be more particular.

On the eastern shore of the lake the black slate appears at numerous points, extending almost the entire length of the west line of the counties of Franklin and Chittenden. At Burlington and Shelburne it lies to the west and adjacent to the red and gray sandstone, and at Sharpshin, or Lone-rock point, is plainly seen to pass under the sandstone. In Georgia, St. Albans, Swanton, and Highgate the black slate is separated from the sandstone by a range of dove-colored limestone, which makes excellent lime, and at Swanton is quarried and wrought for gravestones and building stone, for which it answers very well, though rather brittle.

The general direction of the ranges of rocks in the north half of the state, we have found to be, from about S. 20° W. to N. 20° E., but frequently varying somewhat from this direction, as you will perceive from the minutes in our daily journals. The dip on the west side of the principal range of Green Mountains is generally easterly and on the east side westerly, increasing as we approach the mountains; but to this there are several exceptions, and our observations render it probable that we have one anticlinal and two synclinal axes extending through this portion of the state in the direction of the range of mountains. Drift-scratches we have found in various places and in great numbers, varying in their direction from 20° W. to 50° E. of south.

Proceeding easterly from the lake we found in the neighborhood of Highgate Springs the Trenton limestone lying east of the black slate and also the dove-colored limestone and a hard siliceous limestone lying between it and the range of red sandstone, while in Chittenden county we found the sandstone lying between the black slate and an excellent dove-colored limestone, which extends through the eastern part of Burlington and Colchester and the western part of Hinesburgh. This stone is, in these towns, extensively manufactured into quicklime of the best quality; and east of this range, we regret to say, we found no *good limestone* in the whole distance to Connecticut river. We found narrow beds of white granular dolomitic limestone at Richford, Bakersfield and Waterville, which we are disposed to regard as beds belonging to the same range, and which will probably make

tolerable lime. Lime is also manufactured from stone in Johnson, and also in several places from the dark blue siliceous limestone, which abounds in the counties of Orleans and Caledonia and, though quite dark colored and bearing little additional sand, is found to answer for masonry and common plastering. This limestone is usually stratified and the beds frequently alternate with beds of clay and hornblende slates. These strata usually have a very considerable dip, often nearly or quite vertical, and the succession frequently extends from 10 to 30 miles east and west, interrupted only by a few ranges of granite. In a few cases on the borders of the granite ranges, the lime and granite appeaf to alternate, particularly at Peacham, Cabot and Marshfield.

But the deficiency of good limestone in the north-eastern portion of the State is in some measure compensated by the extensive beds of *shell marl.* These deposits are numerous, but differ very much in extent and quality. They are found in Barnet, Ryegate, Peacham, Danville, Walden, Woodbury, Calais, Hardwick, Greensborough, Craftsbury, Sutton, Glover, Derby, Holland, Brookfield, Williamstown, and Corinth, and probably in other places, which escaped our notice. These beds are usually in the bottoms of ponds or marshes, and covered to a greater or less depth with muck or peat. They have evidently been formed by the accumulation and comminution, or crumbling, of fresh-water shells, specimens of which are usually found entire in the upper portions of the bed. This marl has been converted into quicklime at several of the beds above named, but it has usually been done in so slovenly a manner, by mixing the wood and marl together, and thus mingling the ashes with the lime, that it has been found of inferior quality for plastering. But when struck in the manner of bricks, and burnt in a kiln with fire beneath, it is regarded as nearly equal to the best stone lime. At Williamstown it is manufactured in this way; and here is one of the most interesting marl beds, which we have examined. It extends over several acres, and was once evidently the bottom of a pond, but is now a dry meadow. The marl is covered to the depth of a few inches with soil, and, below that, it is compact and pure, being uniform in color and texture, and extending, in that portion of the bed where excavations have been made, to the depth of 18 feet. In the north-western part of the state we found beds of shell marl at Alburgh, Grand Isle, and Highgate. That at Alburgh on the farm of Judge Lyman covers 40 acres. It lies beneath a covering of muck five feet deep, and the thickness of the marl, where it has been penetrated to the bottom, is six feet or more. It rests upon a bed of fine blue clay.

These beds of shell marl, we regard as of immense value, particularly for the manufacture of lime in the north-east part of the

state where there is no good limestone, and in all parts for a manure; and we believe that the marl at Alburgh and Grand Isle might be transported with profit to be used upon the light, sandy soils, along the east shore of the lake, which are deficient in lime. This marl has, it is true, been used as a manure at Alburgh and on the Islands, and also at some places in the counties of Orleans and Caledonia, without producing any sensible benefit; but the reason is very obvious. At the former places the soil is a post-tertiary deposit, abounding in marine shells, which previously furnished, by their decay, all the lime which the vegetation required, and in the latter places the soil is abundantly supplied with lime by the rapid decay of the blue siliceous limestone, which is there the common rock.

We have spoken of the beds of *muck* and *peat* with which the marl beds are usually covered. These we have found to be common in all that portion of the State, which we have examined, and these we regard as of the greatest importance to our agricultural interests. Every farmer, who has a good muck bed on his lands, has a mine from which he can dig silver much more successfully than by following the indications of the mining rod, or the more modern, and at present more popular, methods of mesmerism. We were pleased to observe that the farmers were beginning in some few places to avail themselves of these natural resources for the enriching of their lands. As a general thing, however, we have found them totally neglected and regarded as a nuisance rather than any thing of value. In our intercourse with the people we have endeavored to show them the importance of these natural deposits of manure, and we trust the time is not distant when their value will be more truly appreciated.

The ranges of rocks, in the portion of the State which we have examined, which furnish good *building-stones*, are numerous, and the materials are, in many places, of an excellent quality. The limestones and black marble of Grand Isle county are well known and extensively quarried as a building-stone—one of the quarries (Fisk's) having been wrought before the revolution. The range of red and gray sandstone, which extends along near the lake shore through the counties of Franklin and Chittenden, also makes a good building-stone, and is extensively quarried at Burlington and in some other places. Some of the magnesian rocks which pass through the easterly parts of these counties, are also sufficiently compact to answer this purpose. A quarry has been worked in Essex, on the land of Mr. Bliss, the stone from which is so free as to be easily sawed in a common saw-mill, and yet so firm as to serve for door-steps, jambs, &c. In Waterville are two large beds of *steatite*, or *soapstone*—one of which has been more or less wrought for several years. The stone, though rather soft

and easily broken, answers well for many purposes, and the quality evidently improves the further the bed is penetrated. Steatite is also said to exist on the west side of Jay mountain, in the line of these two beds, and they probably belong to the same range. Beds of steatite also occur in Troy, Westfield, Lowell, Eden, Belvidere, Johnson, Sterling, Stow, Waterbury, Moretown and Rochester, all of which were examined by us, with the exception of that in Sterling. They evidently belong to the same range, which continues down through Bridgewater, Plymouth, and other towns, to the south line of the State. These beds have not been opened, to much extent, at any of these places; but several of them appear to be of good quality, and are of very considerable economic importance. The bed at Stow, we regard as one of the best, so far as we could judge by a superficial examination. It appears to be extensive, is quite compact, and, being near the mills where there is good water-power, might doubtless be wrought to advantage. The steatite at most of these beds is accompanied by serpentine, and contains fine specimens of talc and actinolite.

Serpentine is found in Troy, Westfield, Lowell, Waterville, Middlesex, Moretown, Roxbury and Rochester, and is said to accompany the steatite on Sterling mountain, where also is found fine talc and sulphuret of copper. The serpentine in the Missisco valley appears to be in a trough of steatite, as does that also at Waterville, having steatite both on the east and west sides. It is of a good quality, and blocks of any size required may easily be obtained from a hill north-east of Curtis' mills, in Lowell, and less than half a mile from good water-power. The quantity is inexhaustible;—it has, however, never been wrought at any place in the Missisco valley. We have not, perhaps, been able to find positive evidence of the stratification of the serpentine of this valley; but there are several places where it appears like a stratified rock, particularly at a bluff, two and a half miles north of Lowell meeting-house. The serpentine and steatite of the Missisco valley have mica slate on the west, and chlorite slate on the east, and in the north part of the valley are divided by a narrow range of clay and chlorite slates.

The rock which constitutes the central ridge of the Green Mountains, in this portion of the State, forming Jay Peak, Mansfield mountains and Camel's Hump, we have found to be *mica slate.* This is, in many places, sufficiently compact to answer very well for a building-stone, and in many places splits into handsome flagging stones, particularly in Duxbury, on the east of Camel's Hump. In Underhill and Jericho, are beds of mica slate, in which the stratification is so completely obliterated that they might, at first sight, be mistaken for granite. They are split with nearly equal

facility in all directions, and make a very good building-stone. We have found no *granite* or *gneiss*, in place, to the westward of a line extending from the west side of Memphremagog lake to the west line of Northfield. But east of this line are several imporant ranges extending through the counties of Orleans, Washington, Caledonia and Essex, which would furnish exhaustless quantities of the very best of building-stone. The gneiss in the west part of Irasburgh and Coventry might be wrought with the greatest facility, and would furnish a supply for building a city. The same may be said of the granite in the west part of Derby. East of Morgan lake, the layers of gneiss may be raised of the size of a common garden, and broken into any required dimensions. Smith's quarry, at Maidstone, is suitable for mill-stones, and is sufficiently extensive to supply the Connecticut valley for centuries. It is harder to work than the granite farther west, but splits equally well. The quarry on the south-western side of Blue Mountain, in Ryegate, is of an excellent quality, is easily removed from the bed, and is absolutely inexhaustible. Since the construction of the State-House at Montpelier, the excellent quarry at Barre has been well known. These are only a few of the quarries which have been opened, and doubtless hundreds of others equally good might be found in this section of the State. In most of those towns where granite of good quality is not found in place, sufficient quantities of large granite bowlders are scattered upon the surface, for the use of the inhabitants for many years. Mr. Tolman, of Greensborough, has recently constructed one of the best houses in the county, from a single bowlder on his farm;—the walls of the cellar, as well as the house, being of the same material. The granite wrought at Hardwick, and transported down the river, is from similar bowlders.

Several ranges of *clay slate* have been examined by us, from which we have no doubt slate suitable for roofing and other purposes, might be obtained, particularly at Berkshire, Enosburgh, Albany, Coventry, and Berlin. The quarries at the latter place have been wrought for roofing-slate, which was found, we believe, to answer tolerably well. Several buildings in Montpelier and vicinity are covered with it.

Clays are so common, especially in the Champlain valley, that they have hitherto received very little attention. In many parts the clays are more or less calcareous; but in general not enough so, to injure them materially for the manufacture of brick. In several places they are of a quality suitable for pottery, and in all they would be highly serviceable as a dressing for sandy soils—and the more serviceable in proportion as they contain a larger amount of calcareous matter. These calcareous clays, or more properly marls, not only furnish lime and give compactness to

the loose soil, but also increase the value of other manures: and, considering the importance of clays in the arts and in agriculture, we have been highly gratified in finding almost every town in that part of the State which we have examined, well supplied. We recollect of only two towns where a deficiency of clay has been mentioned. On the farm of Mr. L. Bronson, in Greensborough is a bed of clay which may be dug and manufactured into good fire brick without any foreign admixture. It would also probably make very strong and durable pottery; but has not yet been sufficiently tested. Beneath the bed of muck and shell marl, half a mile west of Derby village, is found a siliceous clay, the bricks from which are scarcely diminished in size by burning, and have a strong resemblance to Bristol Brick. It may be found valuable for the manufacture of that article.

We have found *sand*, in several places, suitable, as we suppose, for making glass. The quantity on the shores of Island lake in Brighton and Westmore lake in that town, is very great and is nearly all quartz. Still it contains some feldspar, which might possibly injure it for the manufacture of glass. In the town of Fletcher is a bed of sand extending, beneath the soil, over a large area. This when washed appears to be nearly pure quartz, and would doubtless make glass of the best quality. A bed of sand has been found in Greensborough since our visit to that town, which, from a slight examination of a specimen shown us, we are disposed to think suitable for moulding at furnaces. It is said to be abundant.

The most important *ores* which we have examined, are those of *iron*. Veins or beds of red hematite were examined in Milton, Fairfield, Sheldon and West Berkshire, and the same kind of ore is found beyond the State line in Sutton and Broome, in Canada. These localities all lie nearly in the same right line and probably form a connected range. At West Berkshire where this vein crosses Pike river there is excellent water power and an abundant supply of wood for making coal, and the appearances at the surface lead us to think that ore, for the supply of a blast furnace, might easily be obtained within half a mile of the falls at this place; and the appearances at Fairfield and Milton are nearly equally favorable. The iron made from this ore would undoubtedly be of an excellent quality.

The magnetic iron ore situated in a bed of serpentine in Troy has been proved to be highly valuable and may be wrought to any extent desired. It is a difficult ore to smelt, yet is capable of being worked alone. It is however reduced with greater ease when mixed with a small quantity of the Berkshire ore. At Elmore several localities of iron ore were examined, and we have no doubt that a supply could be obtained from these for a blast furnace. The veins hitherto explored are small, but they are numerous and will probably yet be found uniting into one or more large vein. We were assured that good edged tools had been made directly from the ore in a blacksmith's forge. We also examined a bed of ore in Wolcott, which is highly magnetic and would, doubtless, be easily reduced, but it had not been sufficiently opened to enable us to form any opinion of its extent or probable value. We found small quantities of iron in Fletcher, Underhill, Jericho, Bolton and Huntington indicating an iron range in that direction, but we saw no place along the line, at which we should think much expenditure in exploring would be justifiable. *Bog ore* we have found in numerous places. One of the most extensive beds of this ore is in Underhill on the farm of Mr. Josiah Mead. It is not of much depth but covers an area of some 40 or 50 acres, and may prove to be of value. The *chromate of iron*, which is one of the most valuable ores of this metal, on account of the use made of it in the arts, is found in Westfield, but the veins have not been sufficiently examined to justify an opinion with regard to the amount.

Beds of *sulphuret of iron* or *iron pyrites* were found at Brighton, Waterford, St. Johnsbury, Waterbury, Fletcher and many other places. That at Woodbury is probably the most extensive and may be of value for the manufacture of copperas should the bed of ore at Strafford ever fail. At Waterbury is a rich vein of arsenical iron on the farm of Mr. Gregg, but not having examined the locality personally, we are unable to form an opinion of its extent or value.

Ochres are found in numerous places, as might be expected in a region where iron ores are so common. Beds exist in Hydepark, Westfield, Stow, Waterbury, Swanton, Moretown, Berlin, Barre, Danville and doubtless many other places. That at Hydepark is very extensive, and has been used for a paint. But very little has been done by way of preparing it for market, or bringing it into use at home.

Sulphuret of copper or *copper pyrites* we have found in several places. The most interesting locality visited was Tyson's mine in Waterbury where copper and iron pyrites are found together. A shaft has here been sunk into the rock some 60 or 65 feet and several tons of the ore are now lying in a pile beside it; but the ore not proving so rich, nor so abundant, as was hoped, the mine is for the present abandoned. We were handed a small specimen of copper ore, said to have been obtained on Sterling Mountain. It appears to be of good quality but not having time, after receiving it, to visit the place, we can say nothing respecting the quantity. There is also a vein of copper ore in Corinth which has recently been partially opened.

Although we have found *traditions* of the existence of *lead*, or *silver*, in almost half the towns in the north half of the State, and were pointed to numerous mountains where the celebrated Indian, Capt. Joe and his wife Molly cut out lead with their hatchets, to be used in bringing down the fleet deer and noble moose—and although we have *heard* how the Spaniards, in early times, smelted silver in our mountain caves and buried the ingots at the foot of precipices, and have *seen* where extensive *diggings* have been made under the guidance of mesmerism and the witch hazel, still we can boast of no great success in exploring for these valuable metals. We have examined only one vein of lead ore, and have found no silver, unless it exists in combination with the lead, which is not improbable, since most of the veins of lead ore in New England are known to contain silver in small proportions. The vein of lead ore which we have examined is on the farm of Mr. Metcalf, near the north east corner of Morristown and about half a mile north of the river Lamoille. It appears upon the top of a large hill in a seam of chlorite slate, and may be traced along the summit of the hill for several rods in the direction of the stratification of the rocks. The vein has been opened only a short distance, but in that distance there is an improvement in it, which we think sufficient to warrant still further expenditure in excavating. Lead ore has been found in the east part of Stow, or west part of Worcester, nearly in the line of the direction of this vein and is probably a continuation of it, but our guides were unable to find the spot, and of course we were not able to examine it. Lead ore is also found in small quantities in connexion with the arsenical iron in Waterbury.

In a large part of the towns we have found *springs*, which are regarded as *medicinal*. The most common are such as contain sulphuretted hydrogen and iron, but none of them have yet been analyzed. Those of most celebrity are at Alburgh and Highgate on the west side of the mountains, and at Brunswick, Danville, Newbury, Sutton, Burke, Hardwick, Tunbridge, Plainfield, and Williamstown on the east.

Thus have we presented some of the leading objects of our examination. Numerous subordinate ones will be found particularized in our daily journals, which are herewith submitted, and to which we beg leave to refer you for the minute details of our labors.

S. R. Hall,
Z. Thompson.

September 12, 1845.

Letter from S. W. Thayer, Jr., M. D.

Thetford, Vt., July 29th, 1845.

Dear Sir—Near the mouth of Ompompanoosuc river in Norwich, 2 1-2 miles below Union Village, is a sand-bank which has received the name of "Saddle Back;" it is upwards of one hundred feet high, and is the upper terrace of intervale land in the valleys of the Connecticut and Ompompanoosuc rivers; it is at the terminus of a mountain ridge that is situated between, and to a certain extent runs parallel with, those two rivers from Bradford to Norwich, a distance of 14 miles. Upon the summit of Saddle Back and for several rods in length, it is only sufficiently wide for the construction of a road, the two sides of this bank being nearly perpendicular to a height of upwards of 100 feet. About one mile from the mouth of the river near the base of this bank, there is a clay bed in which are clay stones of almost any quantity, size, and form.

About two miles above the mouth of Ompompanoosuc river, we find mica slate in place containing beautiful garnets, which can be obtained in any quantity with little difficulty. Cobble Hill, situated about three miles above the mouth of Ompompanoosuc river and forming a portion of the western boundary of the valley of the Connecticut, is made up of mica and talcose slates, and steatite. Some beautiful crystals of which have been obtained from this locality, and the stone has been quarried to some extent for the manufacture of jambs, hearth-stones, and for lining furnaces and forges.

On the upper terrace of intervale land in the valley of the Connecticut, on the farm of Bela Child, Esq., in Thetford, is a pond of water covering ten acres of land, the eastern shore being less than ten rods from the bank of the river, and 153 feet above it. In sounding, 53 feet has been the greatest depth found, and there is no stream passing into or out from the pond. This body of water seems to be lodged in a basin of clay, and by observing its rise and fall we find the depth does not vary two feet during the different periods of drought and flood. I have been informed by Col. Hosford and Mr. Chamberlain (sons of the two first settlers of this town) that they have heard their fathers repeatedly say that "when they came to town, this pond was well supplied with perch and dace," many of which were of a larger size than any which have been taken from it since. The water is used for all domestic purposes.

Near the northern line of Thetford, the best of building-stone has been quarried, as is shewn in the neat and durable stone-house on the farm of Wm. Kingman, Esq. The mountain, from which the building-stone is taken, is but a short distance from the Con-

necticut river, and the position of the stone for quarrying is as favorable as the Quincy quarry. Some beautiful crystals of quartz and good roofing-slate are found upon the farm of T. P. Bartholomew, Esq. The slate has been used for covering buildings in the neighborhood, and has been found to answer a very good purpose. In several places along the base of the ridge, (which I have before referred to as forming the western boundary of the valley of the Connecticut, from Bradford to Norwich,) slate-stone is found, which presents a contorted appearance—some specimens being considerably warped upon themselves, which fact has led many of the searchers after hidden treasures to suppose, that the huge masses of primitive rocks entering into the formation of the mountain-ridge, were resting upon rich beds of coal; but I am not at a loss to know what must be the result of the labors of the coal-hunter, who confines his labors to any or every district of country east of the Green Mountains, with which I am acquainted.

About 100 rods from Thetford Hill, is located the *lead-mine*, which has been considerably worked at different times, but has never been a source of much profit to those concerned in the operations of smelting—the best specimens yielding only from 35 to 40 per cent.

The ore is found in veins, varying from one to four inches in width, traversing a ledge of mica slate, from the south-west to the north-east, associated with quartz crystals and blende. I am not aware that the blende has ever been smelted, as I had no knowledge of its existence here until a short time ago. In the western part of this town, there has been recently found *in place*, quartz traversed by crystals of black tourmalin. A specimen sent to me by a coal-hunter, is of white quartz, and the tourmaline of small delicate jet-black crystals. The bowlders found in Thetford are granite from Corinth or Barre, sienite from Fairlee, limestone from Vershire, and several varieties of porphyry, from regions unknown. I have found a few bowlders of hornblende in Thetford, Fairlee, Vershire, Strafford, and Norwich; but where their home is, I know not. I have invariably found them upon the eastern declivities of our highest hills, near the summit.

I have found some bowlders which have much the appearance of conglomerate rock; but what business they have here, I cannot divine: there are only about twenty of them, and they are confined to a few acres of ground.

We have an abundance of clay in nearly every district in town, which answers every purpose of the mason and potter.

Vershire is made up principally of limestone. Twenty years ago it was considered a poor farming town; but since the land has become generally cleared, and the surface of the ledges exposed to the action of the elements, they have broken down, and formed a soil of the best quality; and the town now stands amongst the first of the county in point of agriculture. A pretty good quality of marl is found in the beds of the streams throughout the town.

In East Fairlee, near Orford Bridge, a mountain mass of gneiss stands upright, with nearly a perpendicular face, to the height of upwards of 100 feet. Upon the opposite side of the river we can see a mountain, which, in point of height, &c., corresponds well with the one upon this, which seem to have once been united, so as to form a barrier that supported an ancient lake above—the waters of which, covered the beautiful meadows of Newbury.

I have given you a brief outline of what would most interest you here; and, in doing it, I have prolonged my communication beyond what I expected when I commenced.

Your obedient servant,

S. W. Thayer, Jr.

Letter from James Robbins, M. D.

Chester, Sept. 24, 1845.

Dear Sir—I give you, at your request, a hasty description of the minerals of our town, but fear it will contain nothing worth penning.

Actinolite, massive and crystalized, in steatite and talc, is found upon the farm of Mrs. Davis, in the southwest part of the town, about 100 rods from Grafton line. At this place there has been a considerable quantity of steatite quarried; but it is not worked at present, on account of its containing so much of rhomb spar. At this locality we find actinolite, steatite, talc, rhomb spar, and black mica, in large masses, with a lamellar structure. Asbestos, in large quantities, in connection with steatite, is found upon the land owned by Alvah Thompson, in the north-west part of the town, and within fifty rods of Ludlow line. It is upon the range of hills east of the north branch of Williams' river. I have obtained a specimen between two and three feet long, but it would now be difficult and perhaps impossible to obtain one as long. Steatite, asbestos, talc, serpentine, and mica slate, containing garnets, are found at this place. Augite in quartz and flesh-colored feldspar are found in abundance upon P. F. Bouker's farm in the S. E. part of the town, and also between the North and South villages. Chlorite is common throughout the town in small masses. Epidote, crystalized and granular, is found upon the farm occupied by Jesse Stedman, one-half mile from the South village, in

a south-east direction. At the same locality we find massive garnet, hornblende, and smoky quartz. Sulphuret of iron, in small quantities, in granite, gneiss, mica slate, &c., is found. Jasper is found in our brooks and gravelly hillocks, and kyanite in the west part of the town, in common quartz. The crystals are grouped in various forms, some diverge from a common centre—stellated, corrugated—and others are pressed, as it were, into a triangular form. Quartz granular, ferruginous, smoky and milky—are found common throughout the town, but more plentifully in the eastern part. Garnets and staurotide are found crystallized in mica slate. Carbonate of iron in very small quantity is found upon Dr. Barrett's farm south-west of the South village. Bog iron ore is found one-fourth of a mile South of the town centre upon Dr. Edson's farm. The bed as far as I have examined it extends in breadth some two or three rods. Black tourmaline is quite common in town, found principally in quartz. Hornblende slate occurs about one mile north-west of the centre of the town. Several varieties of granite, gneiss and sienite are also to be found—but the dip of strata—their connection with each other, &c., I cannot give you, for I am not well versed enough in the science. There are four beds of clay situated upon the three branches of William's river, and have all been used for making brick and earthenware. One situated near the centre of the town is the very best for bricks, superior to any other in this region, but they cannot make earthenware from it. I have been told that it contained great many clay-stones. Swamp mud has only been used by one person in town, and that by Dr. Edson, who informs me that he had a piece of land remarkable for its barrenness, and by way of experiment, he put upon it, direct from the swamp, a quantity of the mud. He found that it improved it, and now by the use of the swamp mud only he has made it the best piece of land upon his farm. He now makes use of about two hundred loads annually. Some he puts in his yard, and some directly on his land.

Yours, &c.

JAMES ROBBINS.

Letter from Dr. E. H. Drury.

PITTSFORD, September 22, 1845.

PROF. C. B. ADAMS:

SIR,—I take the liberty to send you a few specimens of black lead, which is found in great abundance in the south-east corner of Brandon, in what is called Sugar Hollow.

It is all found near the surface—some in large ledges, and that of Mr. Noyes in a vein running north and south. The vein is about three feet wide, between slate rocks, which are filled with quartz. I send you some specimens of the rock found in connection with it—also a small portion of the earth.

This mineral is bought by Mr. White of Ticonderoga in the State of New York, at $5,00 per ton, at the mine, before it is dug. He has bought a few tons a year, for two or three years past. The Conants have also used it for two or three years, for the dressing of their stoves, for which it is said to answer a very good purpose.

If I mistake not, there is *any* quantity of it in that neighborhood. Its locality is about one mile north-west of Mitchell's iron and manganese mine, in Chittenden.

Your friend, E. H. DRURY.

Letter from Mr. Edwin M. Snow.

POMFRET, Windsor Co., Vt., April 28, 1845.

PROF. ADAMS:

DEAR SIR,—In a paper, just received, I find a number of questions which you desire to have answered with reference to each town in the State. I send herein some information with regard to this town.

1. Question—No ores known in town except manganese. There are four localities in the north part of the town, where the "bog manganese," or "black wad" is found, at the outlet of swamps, form tuberose. It has been dug to some extent, and used for painting, which I think is a novel use of the article. One location is very near Snow's store, P. O., where you can find specimens and all particulars of location, value, use, &c. 2—Know of none. 3—A rock, commonly called 'limestone,' is very plenty. When fine, it effervesces with common acid. Outer surface often decomposed into black rotten-stone. Frequently mingled with, and running into quartz. 4—None. 5—A large quarry of beautiful granite in the south part of the town, used for building. Rather light color. 6—None. 7—Cannot answer. 8—Do. 9—A change in the course of a brook has recently exposed a deposit of sand, very fine and free from dirt. Extent unknown. In it are two layers of very beautiful clay, fine, free from grit, and nearly white when dry. Location within 50 rods of Snow's store. 10—Know of none. 11—Some swamps. 12—Yes. By Obed Whipple, and by Crosby Miller. 13—Result not yet known. 14—none. 15—Some beds of clay. One situated three-quarters of

a mile up the brook from Snow's store, P. O., formerly used for brick. Excellent for that purpose, but relinquished for want of sand. Another said to be good, half a mile east of Snow's store, near Mr. Bingham's. 16—Plenty of clay-stones in the first mentioned bed, mostly flat and round. A few specimens left at Snow's store Post Office. Formerly I have seen clay-stones of very curious forms, near Doubleday's, north part of town, but have not been able to examine there this spring. 17—None important. 18—Bowlders of granite very plenty, mostly small. 19—Quartz crystals formerly very plenty half a mile from Snow's store. I have one six inches long, by two and a half to three in diameter.

Iron pyrites, common—form, cubical. Garnets, plenty. Schorl in fine crystals, in quartz, is common.

The strata in this vicinity dip at an angle of rather more than 45° nearly west. The strike is therefore nearly north and south, and the outcroppings are on the east side of the hills, where are some nearly perpendicular precipices, exposing many strata.

You perceive that my information refers to the north part of the town. You will find in the south part of the town, Gardner Wilson, Esq., and at the Centre P. O. Crosby Miller, Esq., and the Messrs. Chamberlin, interested in giving you information.

Respectfully yours,

EDWIN M. SNOW.

Circular published in April, 1845, and referred to in the letter of Mr. Snow.

Having been commissioned by his Excellency the Governor to make a Geological Survey of Vermont, I venture to ask the co-operation of my fellow citizens in a measure so intimately connected with their prosperity. In each town gentlemen can, with little effort, communicate information, which may prove valuable to their towns and to the public generally.

In a few weeks I intend to commence the field labor, as will also my assistants, and we hope in the course of the summer to pass over most of the State, making a general reconnoissance of the rock formations, preparatory to a more minute examination in the following years. Any gentlemen who will leave in charge of the Post-Master of their town *specimens* and descriptions of such objects as they may deem interesting or valuable, with directions for finding their localities, and also answers to the following inquiries, addressed over their names to the subscriber, will confer a great favor. With such gratuitous assistance we shall be able to judge of the importance of an examination of

the ore, marble, mineral, clay, or marl. Let no one infer, however, if we cannot find time the first year to visit the localities pointed out, that they will not be examined subsequently.

To direct attention to the most important points, we add the following questions:

1. Do you know of any kind of ore in your town?
2. Any red or yellow ochre?
3. Any ledges or beds of limestone or marble?
4. Soapstone or serpentine?
5. Any rocks good for building stones, millstones, whetstones, or firestones?
6. Any good roofing slate?
7. Any materials for glass, for fine porcelian, or for common pottery?
8. Any materials useful for fluxes?
9. Any moulding sand?
10. Soils remarkable for fertility, barrenness, or for bearing only certain crops?
11. Are there any deposits of peat, marl, swamp mud &c.
12. Have any marls, peat, swamp mud &c., been used on the land?
13. Have any such substances benefitted or injured the soils?
14. Has any peat been used for fuel?
15. Is there a fine white substance beneath the peat or mud?
16. Are there any clay stones in the clay?
17. Are there any remarkable ledges of rocks, or caverns?
18. Are there any large loose blocks of stone?
19. Are there any other valuable or curious minerals?
20. Are there (in the western towns) any curious petrifactions in the rocks?

Specimens of any of these substances will be very acceptable, and since it may be expected that sets of specimens will be furnished to several literary institutions and to the medical colleges in the state, as well as to the state itself, several of a sort are desired. Perhaps also the legislature may deem it expedient to make provision for furnishing each county with specimens illustrating its own geology. I would especially request of the proprietors of beds and veins of ores, and of marble, soapstone, or serpentine quarries, fair specimens of these substances, (since they will come under the observation of the public generally,)* or at least one good specimen for the state collection.

* Specimens of *common* minerals, rocks, marbles, &c. may be four inches long, three inches wide, and one or two thick, unless a larger size may be necessary for a fair exhibition, The size and form of *valuable* specimens must depend on the character of the mineral. In all cases they should be kept free from bruises and scratches, and carefully wrapped in paper with labels indicating their locality and the name of the donor.

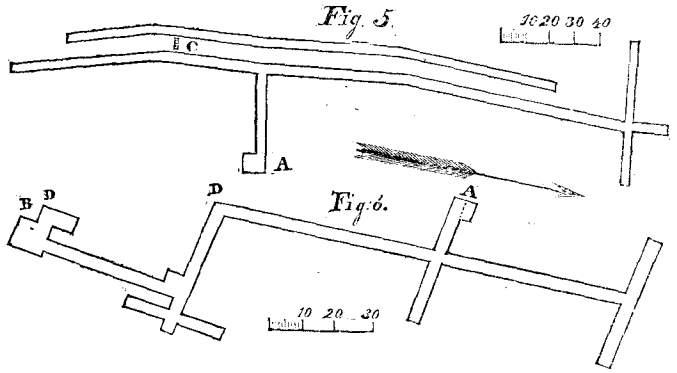
I also request gentlemen to furnish me, in writing, with such statistics, as they may be willing to make public, of the amount of iron, manganese, copperas, lime, marble, soapstone, serpentine &c., obtained during the last and previous years, of the expense, profits, improved modes of quarrying, or other valuable information.

Editors are respectfully requested to give this address an insertion.

C. B. Adams, *State Geologist.*

Plan of the Galleries in the Mine at Mitchell's Ore-bed in Chittenden.

Since writing the description of this ore-bed, (p. 20), I have received by the kindness of Dr. Ewing of Pittsford, a plan of the works, from which figures 5 and 6 are taken.



Explanations.—A is the shaft, fifty-four feet from the surface in figure 5, and sixty-two feet in figure 6. B is the solid bed of ore mentioned in the description of the mine. C is a ladder communicating with an abandoned gallery in the west side of the mine. D is the limestone ledge.

Letter from C. W. Conant, Esq.

Brandon, October 7, 1845.

Dear Sir,—Your favor of September 15th, making inquiries in regard to the amount of business, number of men employed, &c., in our furnaces, was duly received, and I am happy to communicate some of the principal facts as requested.

We manufacture annually about 1200 tons of pig iron in our two furnaces, and 800 tons of castings for stove plates, machinery,

&c. &c.—the ore from which it is made yielding on an average 50 per cent. of the purest metal.

This work gives employment to about 200 men directly, besides a large number of colliers and teamsters who are chiefly engaged in this business through the year.

We have, as you know, inexhaustible beds of manganese of the finest and purest quality, which are worked more or less, according to the demand for the article, and the competition of other beds. Transportation is the main obstacle to more extensive mining, both of manganese and of iron ore. And as this incubus is in process of removal, another day will witness an extension of our business, which would now appear to be exaggerated by any approximate estimate.

I have not an opportunity to write more particularly or at length at this time; but shall be happy to be of any farther service to you hereafter, if desired.

Very truly yours, C. W. Conant.

Expenses of the Survey.

The Expenses of the Geological Survey, commencing March 1, 1845, up to September 15, 1845, have been as follows:—

Travelling expenses of principal and assistants,	$321.38	
Salary of Principal Geologist,	325.00	
Services of President Hitchcock,	75.00	
Salaries of two field assistants,	400.00	
Services of occasional assistants,	89.43	
Apparatus and expenses at depot of specimens, including shelves, rent, &c.	78.68	
Postage and transportation,	46.73	
		$1336.22

The estimates for the remainder of the year, up to March 1, 1846, are as follows:—

Travelling expenses,	$ 25.00	
Salary of Principal Geologist,	275.00	
Services of occasional assistants,	55.00	
Barometer, case and packing,	68.00	
Expenses of depot of specimens, including rent and fuel,	20.00	
Postage and transportation,	20.00	
Chemical analyses,	200.00	
		$663.00
		$ 1999.22

NOTES.

In this Report the bearings of compass are corrected for variation, 10° W. being allowed. The variation at the N. E. corner of the State is 12° W., at the N. W. part 11° W., as determined by the U. S. Engineers on the boundary line. At Burlington about 10°, according to Mr. Thompson. We were informed, in the south part of the State, that the variation was 9° W.

Since the foregoing report has been in press, it has been deemed expedient to make *the estimates of expenses for the ensuing year* the subject of a separate communication, more deliberately matured.

INDEX OF TOWNS.

GLOSSARY.

EXPLANATION OF TERMS.

Actinolite, a variety of hornblende in long slender green crystals.
Adit, an entrance to a mine nearly or quite horizontal—usually a little ascending, for drainage.
Alembic, a kind of still.
Alkali, any chemical agent which is caustic,& neutralizes acids,as potash
Alluvium, see p. 15.
Amethystine, of the color of amethyst, a violet variety of quartz, used as a gem.
Anthracite, mineral coal which is not bituminous, & burns without smoke.
Anticlinal axis, an imaginary line in the rocks, from either side of which the rocks dip in opposite directions.
Apocrenic acid, an acid found in the mould of soils.
Aqueous, relating to water. Rocks of aqueous origin are those which were deposited by water as sediment.
Arenaceous, crumbling into sand.
Argentiferous, containing silver.
Argillaceous, containing or composed of clay.
Augite, see p. 10.
Basalt, see p. 14.
Bed, a layer of mineral matter included between the layers of rock.
Bog ore, see p. 17.
Bowlder, a fragment of rock which has had its angles worn off.
Brown coal, a variety of mineral coal resembling charred vegetable matter, of little use.
Brown Hematite, a fibrous variety of brown iron ore.
Brown iron ore, see p. 17.
Calcareous, composed more or less of carbonate of lime.
Calciferous, containing carbonate of lime.
Carbon, an elementary substance of which coal is chiefly, and the diamond entirely composed.
Carbonate of lime, see p. 10.
Carboniferous, containing coal.
Chlorine, a yellowish green gas, very corrosive & destructive when breathed, with remarkable bleaching properties.
Chlorite, a dark green soft earthy mineral.
Chlorite slate, a kind of slate composed of grains of chlorite and quartz.
Chromic iron, a compound of iron and chrome green.
Concretion, a globular mass composed of layers of particles which have been attracted around a centre.
Compact, composed of grains which are nearly or quite invisible to the naked eye, and more or less firmly coherent.
Conformable ; strata are said to be conformable when they lie parallel with each other.
Copperas ore, see p. 55.
Copper pyrites, see p. 30.
Coral, a rocky mass formed by secretions from minute animals in the warm ocean of tropical climates.
Crenic acid, an acid found in vegetable mould.
Crystal, a mineral body with a regular symmetrical form.
Crystalline, composed of crystals.
Crystallization, the act of forming into crystals.
Dip, see p. 12.
Disintegration, a crumbling into fine imperceptible particles.
Dolomitic ; Dolomite, or a dolomitic limestone, is one which contains magnesia. See p. 46.
Drift, see p. 15,
Dykes, see p. 14.
Encrinite, an animal composed in great part of a calcareous skeleton, affixed to the bottom of the sea by a jointed stem, with a flower-shaped summit.

Fat lime, lime nearly or quite pure.
Feldspar, see p. 10.
Ferruginous, containing iron : colored by iron rust.
Formation, layers of rock which were deposited during the same period of the earth's history.
Fossil, found in the rocks or earth ; the term is usually applied only to the remains of plants and animals.
Fossiliferous, containing fossils.
Fucoid, a fossil resembling sea-weeds.
Galena, see p. 30.
Gallery, a passage nearly or quite horizontal in a mine, usually with a gentle slope for drainage.
Gangue, the mass in which a mineral is embedded.
Geine, a name applied by some to vegetable mould.
Gneiss, a stratified rock which is composed of quartz, feldspar and mica.
Granite, an unstratified rock composed of the same ingredients as gneiss.
Granular, composed of grains.
Graphic, resembling written characters, as graphic granite.
Graphite, see p. 33.
Greenstone, see p. 14.
Gypsum, see p. 33.
Hard-heads, bowlders of quartz rock.
Hard-pan, hard gravel containing some clay.
Hematite, fibrous iron ore.
Hornblende, see p. 10.
Hornblendic, containing hornblende.
Hornblende slate, a slate composed of grains of hornblende and quartz.
Humic acid, an acid found in vegetable mould.
Humus, vegetable mould.
Hydrate of lime, see p. 46.
Hydraulic lime, see p. 47.
Hydrochloric acid, a strong acid made from salt and oil vitriol.
Iceberg, a mass of ice originally formed on a cliff, and floating off to sea, often with more or less gravel and rocks.
Igneous ; an igneous rock is one which was erupted in a melted state, like lava.
Interstratified, lying between the strata
Iron pyrites, see p. 31. under silver & gold.
Iron sand, a sand composed mostly of small grains of magnetic iron ore.
Joints, planes of division cutting across the strata, with smooth faces.
Kaolin, see p. 52.
Lamina, a thin plate of any thing, as of mica.
Lava, the melted matter of volcanoes.
Lithological ; the lithological characters of rock are their mineral characters, in distinction from position and fossil contents.
Littoral, inhabiting the shore.
Maclurea, a genus of marine shells, long since extinct, somewhat resembling, in form, snail-shells.
Magnesian, containing magnesia.
Magnetic iron ore, see p. 23.
Manganese, see p. 27.
Marl, see p. 50.
Metalliferous, containing metals.
Mica, see p. 10.
Mica slate, a slate composed of grains of mica and quartz.
Muck, see p. 51.
New York system, a system of stratified rocks fully developed in N. York, comprising most of the older palæozoic formations.
Nodule, a lump more or less globular.
Obsolete, indistinct, as if obliterated by some change.
Ochre, see p. 34.
Octahedral, having eight three-sided faces.
Organic ; all animal and vegetable bodies are said to be organic, because composed of organs or vital apparatus.
Orthocera, a genus of shells long since extinct, straight and conical, and divided into numerous chambers by tranverse partitions.
Oxide, any substance combined with oxygen gas, and not acid, is an oxide ; thus oxide of iron is the metal iron combined with oxygen.
Palæozoic,containing ancient animals: see p. 15.
Peat, decayed vegetable matter, more or less compact.
Pelagic, inhabiting deep water.
Plumbago, see p. 33.
Polyparia, corals.
Porphyry, see p. 14.
Porphyritic, see p. 14.
Potsdam sandstone, a rock composed of grains of quartz—the oldest rock of the New York system.
Primary ; primary rocks are the oldest rocks.
Pseudomorphism, the substitution for the crystalline form proper to any mineral of a form proper to some other mineral.

Pulverulent, crumbling to powder.
Quartz, see p. 9.
Quartz rock, a rock composed of quartz
Red ochre, see p. 23.
Red hematite, see p. 23.
Red oxide of iron, see p. 23.
Reverberatory ; a reverberatory furnace is one in which a dome reflects the flame down on the ore.
Saccharine, sugary.
Saccharoid, resembling white sugar.
Sandstone, a rock composed of grains of sand more or less firmly coherent.
Secondary, see p. 15.
Serpentine, see p. 38.
Shaft, a perpendicular descent to a mine.
Siliceous, more or less composed of silex or quartz.
Soapstone, see p. 37.
Spalt, to split into irregular fragments
Specular oxide of iron, or specular iron ore ; see p. 23.
Sphagnous, abounding with sphagnum, a kind of moss.
Stalactites, mineral substances in the shape of icicles.
Steatite, see p. 37.
Strata, layers of rock.
Stratified, composed of strata, see p. 11.
Streak, the color obtained by filing mineral.
Synclinal axis, an imaginary line towards which the strata dip from either side.
Talc, see p. 11.
Talciferous, containing talc.
Taconic system, a system of stratified rocks lying between the New York system and the primary rocks of the Green Mountains.
Talcose slate, a slate composed of grains of talc and quartz.
Tertiary, see p. 15.
Trap, see p. 14.
Transition, see p. 15
Translucent, admitting of the passage of light, less than transparent.
Tympstone, in an iron furnace, the stone beneath which the melted iron is drawn off.
Unconformable, not conformable, which see.
Veins, see p. 14.
Virtreous, resembling glass.

GENERAL INDEX.

ERRATUM—Page 54, line 7th from top, for $40.00, read $2.00.

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