THIRD

ANNUAL REPORT

ON THE

GEOLOGY

OF THE

STATE OF VERMONT.

BY C. B. ADAMS,

STATE GEOLOGIST, &c.

BURLINGTON:

CHAUNCEY GOODRICH.

1847.

To His Excellency

HORACE EATON, *Governor of Vermont:*

SIR,

I herewith submit the third 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, 1847.

ERRATA IN THE SECOND ANNUAL REPORT.

From causes, which entirely exonerate the publisher from all blame, some errors occurred in the printing of the last report, which more or less obscure the sense. Since that report was designed to be used until, at some future period, the Final Report should be published, it may be useful here to insert a list of the more important errata.

Page 28, 15th line from the bottom, for 'Sumatra,' read 'Sumbawa.'
" 43, 12th line from the bottom, for '300,' read '3000.'
" 47, the paragraph, which follows the caption '*Oceanic Currents*' should precede it.
Page 57, near the middle of the page, the word '*Tunicata*' should not be connected by a brace with the two names next over it, and should be preceded by the word 'naked.'
Page 60, last line of the first paragraph for 'entirely,' read 'contracted and partly.'
Page 60, four lines below, for '75°,' read '66°.'
" 64, 12th line from the bottom, for 'cattle,' in some copies, read 'battle.'
" 74, near the middle of the page, for 'Iceland,' read 'Ireland.'
" 81, 6th line from the top, for '?,' read '1500.'
" 81, 13th line from the top, for '?,' read '200.'
" 81, 13th line from the top, for '200,' read '600.'
" 84, in the column of formations, for the 4th word from the top, 'pleistocene,' read 'pleiocene.'
Page 98, the 13th and 14th lines from the bottom are transposed.
" 99, 19th line from the top, for 'veracity,' read 'voracity.'
" 102, 16th line from the bottom, for 'warm blooded animals,' read 'quadrupeds.'
Page 118, after the 20th line from the top, insert the following:
4. Trimera; composed of three simple or encyclic forms;
a. with concentric structure.
b. nuclear.
Page 126, 8th line from the top, for the last word 'of,' in the line, read 'from.'
Page 128, 2nd line from the bottom, *dele* 'their.'
" 152, 15th and 16th lines from the bottom, for '15,125,000,000,' read '15,625,000,000,' and for 'one hundred,' &c. read 'six hundred,' &c.
Page 163, the Trenton limestone in the figure at *a*, should be represented as thicker at the expense of the Utica slate.

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GEOLOGICAL REPORT.

Introductory Remark.

On account of the time which must necessarily intervene before the publication of the Final Report, as well as to meet certain expectations on the part of the community, we offered for last year a report more full than is customary for Annual Reports, especially in Elementary Geology. If we are not greatly mistaken, the latter subject requires illustration at the earliest possible period in a popular Geological Survey more than at any subsequent period. It is also in accordance with the plan which has been entertained from the commencement of the survey to submit now, at the close of the field work of the survey, and when about to enter upon the preparation of the Final Report, only a brief history of the operations of the past year, with some notices of a few subjects in Economical or Scientific Geology.

History of the Survey from Oct. 1846 *to Oct.* 1847.

The operations of the last winter were carried on at the geological depot in Middlebury, with the exception of the chemical analyses, which were made at New Haven, Ct. The specimens of rocks, which had been collected during the previous summer, were separated from the minerals, fossils and concretions, and were arranged, trimmed, and assorted for the several collections. They were then ticketed in the manner described last year and a catalogue of the numbers, lithological names, geological age, and localities written out. The series designed for the State collection has been arranged for examination by the Principal in in the geological depot. The specimens which were not included in this series were then carefully put each into two wrappers and the ends of the outer wrappers securely tucked in, in the manner commonly seen in specimens received from Germany; the number of the specimen was written in duplicate upon the

outside. They were then, with the duplicate specimens which had been prepared in a similar manner during the previous winter, assorted for distribution on the following principles, which are now publicly stated agreeably to the pledge in the report of last year.*

(Suite No. 1, is the State collection before mentioned.)
No. 2. for the University of Vermont.
" 3. " Middlebury College.
" 4. " myself, as per original contract with the Executive.
" 5. " the Medical College at Woodstock.
" 6. " " Medical College at Castleton.
" 7. " " Troy Conference Academy at Poultney.
" 8. " " University at Norwich.

Numbers 2, 3, and 4 are of equal value and are next in value to the State collection, which latter is necessarily the only complete series. The value of numbers 5 to 8 is in the order of the numbers, commencing with the most valuable, number 5. The principles which have determined this relative value of the collections are found, partly in the nature of the Institutions which are to receive them, and partly in their location. There is an obvious propriety in assigning to each of the two principal literary institutions of the State as good a suite as the means of the survey can furnish.

No. 4 was designed for the use of scientific men abroad, and therefore should not be inferior to any except to the State collection. Although it is of some pecuniary value, I have concluded to forego all pecuniary advantage, in order to place it where it will secure this object and at the same time be more accessible to the southern part of the State than any of the other collections. It has therefore been presented to Amherst College, which possesses in connection with it, similar series from the Geological surveys of Massachusetts and Connecticut, besides extensive Geological collections from various parts of the world. The number of specimens which have thus far been put into each of these suites is not far from 960. A larger number remain.

No. 5 has taken precedence of number 6 from purely geographical considerations. Number 6 being at no great distance from number 3 and number 7, it seemed due to the vicinity of Woodstock to furnish as good a series as is consistent with the other principles involved. The difference in value is not however very material. The number of specimens already forwarded to Woodstock is 694; to Castleton, 596; to Poultney, 515; and 394 remain subject to the order of Norwich University, not having yet been called for.

*In this work, involving a great amount of manual labor and requiring much care and fidelity in its execution, I was greatly indebted to Mr. P. J. H. Myers of the class which graduated this year at Middlebury College.

The Geographical distribution will be as follows:

In Eastern Vermont.

No. 1. the only perfect series, at Montpelier;
" 5. at Woodstock;
" 8. at Norwich.

In Western Vermont.

No. 2. at Burlington;
" 3. at Middlebury;
" 6. at Castleton;
" 7. at Poultney.

In Massachusetts.

No. 4. at Amherst.

It should be recollected that, with the exception of the last named, the places were determined by your Excellency's predecessor at the commencement of the survey, and I am therefore responsible only for the relative values of the collections. It is believed that their location combines in the best manner their security and utility.

For use before a complete catalogue of the specimens shall be printed, a manuscript catalogue has been prepared and forwarded with each of the collections. It should be observed that the specimens in the several suites, which have the same number, are either exactly alike, or are so nearly alike as to correspond with the same terms in the catalogue.

During the winter, 26 specimens were analysed by Mr. T. S. Hunt in New Haven, Connecticut, in the laboratory of Prof. Benjamin Silliman, Jr. Mr. Hunt's Report will be found in the appendix. Four more specimens were subsequently forwarded to Mr. Hunt, which have been analysed.

About the same time, Mr. Hunt was furnished with a commission as Assistant Geologist, in order that his valuable services might be obtained in the mineralogical department of the survey. Mr. H., however, having been subsequently appointed to a highly honorable place, with a much more adequate compensation, in the Geological survey of Canada, has resigned the office of Assistant in the survey of Vermont. The collection of minerals therefore is, for scientific purposes, quite meagre, because the Geology proper—both from its superior importance to the survey and since it could not from the nature of the case be deputed to others to any considerable extent—has engrossed most of my attention. The funds of the survey have not enabled me to secure the services of a competent mineralogist.

The notes of field labor made during the previous year were then collated, with a view to correction of the geological map, which represents the dominant rocks of the several portions of the State by appropriate colors, and the necessary alterations were made on a map which is deposited in the depot of speci-

mens. Mr. Thompson also prepared a topographical map, (as a basis of a future geological map,) on a large scale, of Lake Champlain and vicinity, embracing that part of the State which is of the greatest interest in scientific Geology. This map contains many topographical improvements on any published map. But since these improvements have been the result of much labor by Mr. Thompson when not in the employ of the State, the right to publish them does not yet belong to the geological survey. There is reason to hope, however, that some arrangement may be made by which this valuable map may be obtained for the use of the Final Report.

A plan of field labor for the summer having been matured, its execution was materially retarded by an unusually late season and by the almost impassable condition of the roads. In the mean time, however, the opportunity was improved to consult Geologists out of the State respecting various interesting subjects.

During the early part of the summer, the concretions collected for the survey were ticketed and put in wrappers by an assistant, Mr. A. R. Holmes, whose skill and experience in this department of labor rendered my personal supervision unnecessary. Including these concretions, the number of specimens already ticketed for the State collection amounts to 2104.

The first Geological excursion was made through the west parts of *Rutland County*, where the valuable quarries or ledges of graphic and pencil slates were observed. The line of ponds which extends from the south part of Sudbury through Wells was found to occupy the place of a long fracture and uplift of the slate formation, the mural face of which fronting to the west is found on the eastern margins of the ponds and with scarcely an interruption for the whole distance. It is worthy of notice that notwithstanding the magnitude of this fracture and uplift, no other formation is thrown up to view. The Drift striæ and rounded and polished rocks were found to be abundant in this region.

Bald Mountain in Greenwich, New York, having become almost classic ground in the discussion on the Taconic system, was next visited in company with my Entomological friend, Dr. Asa Fitch, of Salem, New York, whose acquaintance with the rocks of this region rendered his presence and aid highly advantageous. We had the good fortune to obtain at the locality to the north-east of the mountain a fine specimen of Dr. Emmons' Elliptocephalus asaphoides, referred by Mr. James Hall to a species which belongs to the Champlain series. We did not observe the fossil which is said to belong to "an annellide of the Scolopendrian family," a remark by the way in which there must be some error, since the Annellidans and Scolopendrians do not belong to the same class of animals.

The limestone of Bald Mountain appearing destitute of fossils we could not of course judge of the correctness of its reference to to the calciferous sandstone.* The slates are seen in junction dipping beneath on the west side of the limestone, but on the east side of the mountain the junction is not visible. The position of the nearest portion of the slate and limestone on this side, however, is such as to render it probable that the limestone in turn here dips beneath the slates, so that the evidence of the greater antiquity of the latter is by no means conclusive. Indeed we protest against taking for a type of the order of succession a local example in a much disturbed region, which has subsequently suffered so greatly from denudation as to throw much obscurity even on the mode of disturbance.

In company with Dr. Fitch a short excursion was next made through the north-west part of Bennington County. The vast mountain accumulations of shales, with limestone and marble strata at their bases, the limestone, apparently at least, dipping beneath the shales, furnished problems which are more easily solved by hypothesis than by demonstration, and which require further examination. The general position of these rocks is such as might render it probable that the limestones are the equivalents of the Trenton limestone and of the La Motte limestone of the Champlain series, and the quartz rock—of the Potsdam sandstone, but there has evidently been too great a disturbance in this region to admit of certain conclusions. More conclusive because less disturbed localities we shall have occasion to notice far to the north of the disturbance to which the Taconic range of mountains is due.

We next hastened to fulfil an appointment with Professor Agassiz and M. Desor in Burlington and vicinity. Themselves constituting the fountain head of European Geological science in the department most interesting in the Geology of Vermont, the Drift phenomena, these gentlemen have placed us under great obligations for the many valuable suggestions made during the brief period of their visit. Some of the results of these and of other observations will appear farther on in a few remarks on the Drift of Vermont.

Several excursions were next made for the purpose of examining the characters and relations of the *Taconic rocks*. A section from the shore of Lake Champlain at the north-west corner of Ferrisburgh, due east to the Green Mountains was made in company with Mr. Thompson, whose accuracy and discrimination render his services in the scientific Geology eminently valuable. In this section fossils were collected from all the fossiliferous rocks which appeared, including the upper member of

*Since the above was written, Dr. Emmons informs me that Maclurea magna occurs in this mountain. This fossil would identify it with the La Motte limestone.

the shales. Mr. Thompson also accompanied me to a locality in Highgate, which has the rare advantage of furnishing, in the red rock, fossil shells and fragments of trilobites.* In company with Mr. A. R. Holmes the section of Snake Mountain was re-examined and fossils collected in considerable quantities from the upper member of the shales. Buck Mountain was next examined and found to afford a section similar to Snake mountain, while the prolongation of the section eastward through Waltham into the Stockbridge limestone, of New Haven, afforded a more complete series of the red rock and overlying limestones, with the nearest approximation to a junction of the latter with the Stockbridge limestone, which can be found in the State. The west side of Buck Mountain was found to be a good locality for Trenton limestone fossils.

After making out the above named section on a scale of 250 feet per inch, an excursion was made through parts of Caledonia and Orleans Counties, and through most of the towns of Essex County. In this excursion I was much indebted to Mr. Hall's activity and local knowledge of the rocks and minerals in this portion of the State. Many interesting facts were observed, although no one was sufficiently prominent to be mentioned in this rapid sketch, unless it be the relations between the degree of elevation and forms of the hills and mountains on the one hand, and on the other the capability of the rocks to resist mechanical violence, which in connection with the very distinct northern stoss† sides of the mountains may suggest some remarks under the head of the Drift agency. Throughout this part of the State, Drift striæ are comparatively rare, on account of the perishable characters of the rocks. A large part of Essex County was found to be composed of granite. The preference which settlers have given to the adjacent parts of Orleans and Caledonia Counties over most of Essex County we found to be due entirely to Geological causes.

Mr. Hall had previously made an excursion from Craftsbury to Richford, and had discovered in the latter town the only locality known to us in Vermont of the *Sulphate of Barytes.* It occurs here in considerable quantity. Subsequently to the visit to Essex County, Mr. Hall made excursions into the interior of Essex County and to Windsor and vicinity.

In company with Mr. Thompson, an excursion was next made by water on Lake Champlain north of Burlington. Taking a boat of the smallest size, and an experienced and skilful boatman, Chiotte, whose intimate knowledge of the lake rendered his services doubly valuable, we examined about 80 islands, headlands

* See letter from Professor James Hall, in the appendix. C

†Literally 'struck;' the side exposed to the Drift agency and rounded by it is the stoss side.

and bays. Most of these have rocky shores, denuded of superficial materials by the waters of the lake, and furnish a great number of highly interesting details, so that each day's progress seemed crowded with the observations of a week. From Burlington to Savage Island trap dykes were numerous, and afforded many instructive series of specimens from the extremely hard and tough fine grained exterior portions to those in the interior which were coarse and often too friable to furnish good cabinet specimens. Some of these dykes are beautifully amygdaloidal, the cavities being filled with calcareous spar, and others are ornamented, in parts which have a given relation to the exterior, with quite distinct numerous shining crystals of hornblende. The Hudson River shales which occupied the east parts of the lake, afforded abundant opportunities of observing the difference between the planes of cleavage and those of the true bedding. The former are highly inclined, like the lamination of the crystaline slates in the interior of Vermont, and are very conspicuous, while the latter, sometimes obvious from the alternation of more calcareous strata, are usually feebly indicated by different shades of color, such as would be *totally obliterated* by a metamorphic agency barely sufficient to induce an incipient crystalization. The Trenton limestone and the La Motte limestone furnished fossils abundantly, and the latter abound with fine localities of building stones and marbles, which will receive a more special notice.

It had been my intention to make a similar excursion on the lake south of Burlington, but this was confided to Mr. Thompson, in order to avail myself of an opportunity to conduct President Hitchcock to some localities of the most importance in reference to the question of the Taconic system. In his company the sections of Snake Mountain and Buck Mountain were re-examined, as also the approximation of the Stockbridge limestone to the red rock series. We also availed ourselves of an opportunity to make a valuable collection of specimens of polished and striated rocks at Shoreham.

The number of specimens collected during the present season is not far from 3000.

The few towns in eastern Vermont which were not included by Mr. Hall in the last report of the Agricultural department of the survey, were subsequently visited by him. It had been hoped that this useful labor would be continued and that a similar agricultural survey of western Vermont would be made during the present year. But the funds of the survey have not permitted much attention to any other than strictly Geological subjects.

Before the coming winter the Principal Geologist will remove to Amherst, Massachusetts, and although the change of residence is not made primarily on account of the remaining duties of the

survey, it is such as will in no small degree facilitate their prosecution, in the manner which I have explained in a former communication to your Excellency. The depot at Middlebury will be given up, and the specimens of rocks and minerals are to be removed to Burlington, to a depot which shall be in charge of Mr. Thompson, who will assist in the arrangement, ticketing, and distribution of them. The fossils, which now require much time and careful examination by the Principal, will be removed to another depot in Amherst, and may occupy a considerable portion of the winter. In the same depot also will be temporarily deposited, for the daily consultation necessary in making out the result of the survey, the series which is designed for the State collection. The remainder of the winter will be occupied in collating the field notes and in making the necessary plans for the preparation of the Final Report.

Preparation of the Final Report.

The time and funds provided in the bill for the Geological Survey, will be exhausted on the first of March, 1848, and additional time and funds will be necessary for making out the results of the survey. In the annual reports but a small part of these results has been given, and this has necessarily been done in a disconnected manner. The systematic description of the facts and the general inferences to be derived from them, would merit much time and labor, even if any considerable portion of the facts had already been described. This latter, however, is not the case. If we may be allowed a familiar illustration, the process of the Geological Survey thus far has consisted in finding and bringing together the various materials, which are yet to be used in the construction of the edifice. Some benefits we hope have already resulted from the survey, but it still remains to make it a source of permanent utility.

The greater part of the materials requisite for the Final Report has been collected. It is very desirable, however, that certain parts of the State which have received little or no attention in the field should hereafter be visited. Occasional excursions will also be necessary in the progress of the work for re-examination of important localities, filling up deficiencies in the Geological Map, &c. Some chemical analyses will be necessary, and if an appropriation should permit, the agricultural part of the survey might be completed in the manner in which it has been commenced. It is estimated that an appropriation of $1600 per year for two years may be sufficient to secure the completion of the Final Report, and that $200 for one year would secure the completion of Mr. Hall's Agricultural Survey. A more detailed estimate may be found in the Appendix.

ECONOMICAL GEOLOGY.

MATERIALS FOR ARCHITECTURE.

Granite.

THIS rock is rare in Western Vermont, and abundant in Eastern Vermont. It occurs in Stamford, Guilford, Dummerston, Rockingham, Springfield, Braintree, Thetford, Fairlee, West-Fairlee, Bradford, Corinth, Newbury, Washington, Williamstown, Barre, Orange, Topsham, Montpelier, Plainfield, Groton, Ryegate, Calais, Marshfield, Peacham, Barnet, Woodbury, Cabot, Danville, Hardwick, Walden, Craftsbury, Greensboro', Albany, Glover, Irasburgh, Barton, Coventry, Brownington, Newport, Salem, Derby, Sheffield, Sutton, Westmore, Charleston, Morgan, Holland, also in all the towns in Essex county which are accessible by a wagon road, and probably in all the others. The principal masses are one in Essex county, (the greater part of which is granite,) and that of which the well known Barre granite forms a part, the latter occupying about 150 square miles. The total is probably not far from 600 square miles. Some of the best quarries are in Barre, southwest corner of Irasburgh, Coventry, and east part of Morgan. Quarries are not uncommon in which large tables with an even surface are obtained with great facility on account of the natural joints. A remarkable example occurs at Irasburgh.

IRASBURGH. In the southwest corner of the town, at the eastern base of Kelleyvale mountain, the granite occurs in enormous tables, whose faces have a dip of 80° to 83° east, and which are from 1 to 3 feet thick. They are divided by another set of joints which are from 3 to 12 feet distant, and which have a southerly dip of about 55°. Blocks from 3 to 12 feet wide and from 20 to 40 feet long, and 2 to 3 feet thickness, might be obtained with little or no splitting except so far as necessary to square the ends. This granite is not perhaps sufficiently fine for all purposes, but is chiefly remarkable for the facility with which large regular

blocks may be obtained. From its location, however, distant from any large town or rail-road route, it is likely to be an object of curiosity rather than of any considerable profit.

Limestone and Marble.

Of the very numerous localities which we have visited during the last season, we now notice two, because they have been considered with reference to the location of the State's Prison. A considerable number of localities may hereafter be named, on the shores of Lake Champlain, where the joint result of the action of frost and of the natural joints have thrown out great numbers of quite regular blocks of various forms and dimensions suitable for flagging or building stones, and requiring but little preparation for use.

SHOREHAM. The quarry known as Judd's quarry has been mentioned in previous reports, and a section given in that of last year. In respect of the *quantity* of marble at this locality, the same is true here as at other localities, where the same geological formation, the La Motte limestone, occurs, viz. that it consists of very thick and regular beds with a slight dip, so that there is little danger of ever finding the termination of the beds. There may be in the thickest part of the quarry 25 to 30 feet thickness above the level of the lake, which thickness is probably continued indefinitely to the east beneath the overlying materials and is diminished to the north by a dip of about 8°, so that at a distance of a few rods north the upper beds must descend to the level of the lake. The quantity contained in 10 acres, therefore, is probably about 4,000,000 to 5,000,000 cubic feet.

These beds of marble are covered with several feet of Trenton limestone, a rock easily broken up, and of brown clay. It would seem, however, that there must be considerable expense in uncovering them, but of the actual amount of expense I do not profess to judge.

This black marble in respect of beauty and facility of polishing probably is not surpassed in this country. Blocks of it have commanded in the market a higher price than the beautiful Irish black marble. There is also in the lower part of the quarry a variety of a dark drab color thickly motled with blackish ramose forms, which, although a little inferior in the ease with which it is polished, forms a very rich and elegant marble.

The fragments of this marble with a little expense may be converted into a very fat lime, which takes eight parts of sand to one of the lime.

A special committee having investigated the statistics of these quarries, we offer nothing on this subject.

ISLE LA MOTTE: *Fisk's Quarry.* We have received the following communication from the enterprising proprietors of this quarry:—

"Statement of kinds of stone in Fisk's quarry at the Isle La Motte, commencing at the top of the quarry.

Top stratum,		1	foot	high.		
2nd	"	5	feet	"		
3d	"	0	"	10	inches	high.
4th	"	4	"	2	"	"
5th	"	2	"	2	"	"
6th	"	3	"	0	"	"
7th	"	2	"	0	"	"
		18	"	2		

Then comes on 10 feet of grey limestone, and then 10 feet of light-grey limestone, making in all 38 2-12 feet of quarry breast. The above strata can be cut with wedges to any dimensions to suit the market. The upper strata have been most worked in, and a very large quantity has been shipped to Canada within a few years. For fortifications and barracks on the Isle aux Noix, it took 484,000 cubic feet; for the locks on the Chambly canal, 136,000 feet; for foundation to barracks at St. Johns, about 20,000 feet, and the last season for abutments and piers to bridge over the Richelieu river at Chambly, 12,095 feet, and 10,000 feet for the fort at Rouse's Point, N. Y. For the last ten years there has been sold to average about 6,000 feet annually of blocks that are sawed into hearths and sent to New-York, Boston, and Philadelphia. Those blocks we sold for 20 to 25 cents per cubic foot. When sawed into hearths, each cubic foot makes seven superficial feet of hearths. The average price in New-York of hearths has been about 30 cents per foot.

We have also shipped during the above time large quantities of building stone, posts, caps, sills, &c. for various buildings in different places, some of which may be seen in the jail and private buildings in Burlington, and in almost every other place of note on the lake. We this year have a contract to furnish 40,000 cubic feet for abutments and piers for the St. Lawrence and Atlantic rail-road bridge over the Richelieu river near Belœil.

We pay 8½ cents per foot for transportation, about half a cent for duties and canal toll, and receive 21 cents per foot delivered at the bridge. The expense of quarrying it is 6 cents, leaving a nett profit of 6 cents on every foot. The hearth blocks give a profit of 12½ cent per foot. We pay our men from 80 cents to $1.50 per day. The price for cutting stone for building is 3½ cents per superficial foot, which is not included in the stone above, as they are delivered in the rough state and cut at the expense of the purchaser.

TO PROF. C. B. ADAMS.

HODGSON & FISK.

Isle La Motte, August 26th, 1847."

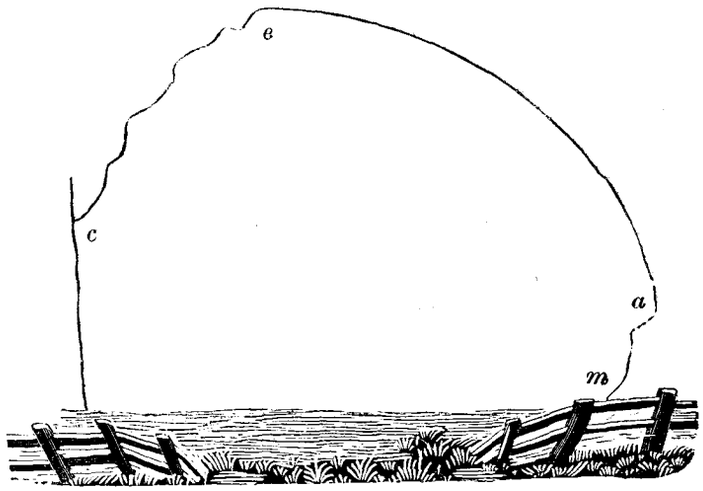
The great quantity of thick beds of limestone, with perpendicular seams at convenient intervals to facilitate the process of quarrying, the ease with which they are taken out from their nearly horizontal position, and with which, owing to the depth of water near the shore which they compose, they are shipped —these circumstances conspire in a remarkable manner to render this the best locality for building stone which we have seen.

Each acre contains about 1,000,000 cubic feet of good building stones above the level of the lake, through an extent of many acres. Some of the beds also are good marble, and in one of the lower beds is a stratum of grey marble, 8 to 12 inches thick, which contains very thickly disseminated crystals, the angular fragments of encrenites, whose stems are of a bright pink color. Having had a specimen polished, we can testify to its beauty and adaptation to ornamental purposes.

The southern extremity of this island consists of thick bedded limestone, divided by seams very conveniently for building purposes, but more siliceous and consequently not so easy to be worked.

Water Lime.

We allude to this subject here for the purpose of suggesting that materials for hydraulic cement may be found in the subconcretionary strata of dark argillo-siliceous limestone, which occur abundantly in the slates in the northeast part of Lake Champlain, and which are so easily recognised by their weathering with a brown ferruginous surface.



Outline of the Rock in Bolton, refered to on the opposite page.

ON THE STOSS AND LEE SIDES OF LEDGES AND OF MOUNTAINS.

We had observed that very generally the north and west sides of ledges of rock, being most exposed to the Drift agency, were well rounded into the *roches moutonnees* of European writers, and that the opposite sides had generally escaped the influence of this agency. To the former or struck side, has been applied the epithet *stoss*, (Swedish for struck,) and the latter is called the lee side. One of the most interesting examples we observed last year, on the south side of the Winooski, in Bolton, about one-half mile east of the line of Richmond. In this example there is a peculiarity, that the rock is shelving on the stoss side, as below *a* in the figure. *a e* is the stoss surface covered with furrows and striæ, and *c e* the lee side. *a m* and *c e* are entirely destitute of any marks of Drift agency, but retain their original inequality. Prof. Agassiz, to whom I had the pleasure of showing this interesting example, suggested that the surface *a m* proves that the Drift agency was that of a solid. Any bodies moving in a liquid, like boulders and pebbles in water, would have exerted their greatest force against this shelving surface.

I am indebted to M. Desor, for a hint respecting the stoss and lee sides of mountains. The present form of mountains appears to be chiefly due, omitting causes of subordinate influence, to three causes; viz. the original form, the composition and structure of the rocks of which they are constituted, and the Drift agency. The results of the latter agency, consequently, in producing the distinction of stoss and lee sides of mountains are modified by the two former causes. Thus the lee sides of many of the Green Mountains are on the east, the Drift agency coming from the west of north upon rocks with a nearly perpendicular dip (of cleavage?) and a strike a little to the east of north. The position also of the mountain, affecting its exposure to the force of the Drift agency, has determined the degree of influence from this agency as compared with the other two causes above named. Thus, in Camel's Hump, the present form is due almost entirely to the Drift agency, the steep and irregular lee side being on the south, and the well-rounded outline on the north, for this mountain, rising up suddenly on the south side of the Winooski, unprotected by any considerable elevation to the north or west, received the full force of the Drift agency. But on the other hand, Mansfield Mountain, having been protected in part by lofty mountains to the north, does not exhibit any distinct north stoss and south lee sides, but the east is the precipitous side. It is obvious that a position at right angles to the line of Drift agency which passes through the mountains observed is the most favorable for correct observation of its influence on their form.

Some very beautiful examples of the stoss and lee sides of mountains occur in Wheelock and in Brownington and Westmore.

In the last Report we stated, in accounting for the Drift agency, the Murchisonian theory of vast masses of loose materials moved by waves of translation so as to act in the manner of a glacier. M. Desor suggests to me that such loose materials, if acted on by moving water sufficiently to acquire motion, would not act in the manner of a glacier, but must assume the properties of a liquid. This objection coincides with the suggestions of a friend well versed in mechanics, to whom I had previously stated this problem—of a mass of Drift materials impelled by waves of translation, to determine the results with reference to pressure—that there would be little or no excess of downward pressure and that the effects must be chiefly limited to a horizontal force removing perpendicular obstacles on the rocky floor beneath. There seems to be some difficulty with this theory in the want of a downward pressure, especially as the motion is supposed to have been very violent, and must have completely scattered the loose materials through the moving waters, and should therefore have acted in the manner of a liquid.

With the theory of a vast glacial sheet, sufficiently thick to furrow the summit of Jay Peak, it is worthy of notice that the objections lie against the *origin* and *not* against the *dynamics* of the agency. If we consider only the former, the theory appears to be incredible, but if we consider only the latter, as perhaps is most philosophical, we find this theory and no other to be quite free from any serious objections. But on this subject much light is to be expected from the observations made by Prof. Agassiz and M. Desor in this country, and compared with the typical examples of glacial agency in the Alps.

APPENDIX.

A.

Report of T. S. Hunt.

Analyses of Minerals for the Vermont Survey.

1. *White Marble*, (No. 1.) Mauley's quarry, Sudbury. This is a pure carbonate of lime, and being free from magnesia and other foreign substances, will afford a superior lime for bleaching and other chemical operations.

2. *White Marble*, (No. 2.) from Phelps' quarry, Middlebury. This is a pure carbonate of lime like the last.

3. *White Limestone*, (No. 3.) granular, Hardy's quarry, Bakersfield. This limestone contains a small quantity of carbonate of magnesia, and a portion of silica disseminated in grains through the mass. Analysis gives for its composition,

Carbonate of lime,	92.9
Carbonate of magnesia,	5.5
Silica,	1.6
	100.0

4. *White limestone*, (No. 4.) granular, feebly coherent, Webber's quarry, Cavendish. This is a proper *dolomite*, containing carbonate of lime and of magnesia in the proportion of one equivalent of each. Like No. 3, it contains disseminated grains of silica. Analyses gives the following result:

Carbonate of Lime,	53.8
Carbonate of Magnesia,	43.3
Silica,	2.9
	100.0

5. *Greyish white limestone*, (No. 5.) Hancock. This contains a small portion of carbonate of magnesia, silica in grains, and a trace of oxyde of iron. Its analysis gives the annexed result.

Carbonate of lime,	90.3
Carbonate of magnesia,	6.9
Oxyd of iron,	a trace
Silica,	2.8
	100.0

6. *Greyish white limestone*, (No. 6.) Plymouth. This is a dolomite with traces of oxyde of iron.

7. *Brecciated marble*, (No. 7.) Plymouth; a dolomite, containing a little protoxyd of iron and alumina. The analysis of a mixture of the colored and white portions, gave as follows:

Carbonate of lime,	53.9
Carbonate of magnesia,	44.7
Oxyd of iron and alumina,	1.3
	99.9

8. *Dove colored limestone*, (No. 8.) brecciated, Bristol. A dolomite, containing grains of silica and small portions of alumina and oxyde of iron. Analysis gives,

Carbonate of lime,	51.7
Carbonate of magnesia,	40.6
Oxyd of iron and alumina,	3.8
Silica,	3.9
	100.0

9. *Silicious limestone*, (No. 9.) dark bluish gray, Tunbridge. This limestone contains a large quantity of matter insoluble in acids, principally silica. The results of its analysis give for its composition,

Carbonate of lime,	37.8
Carbonate of magnesia,	3.2
Oxyd of iron and alumina,	2.7
Insoluble silicious matter,	55.9
	99.6

The marls are, as usual, carbonate of lime with a little magnesia and earthy matter. In the analysis I separated as much as possible the shells and fibres from the marl. The results are as follows:

10. *Marl*, (No. 11.) Alburgh.

Carbonate of lime,	82.6
Carbonate of magnesia,	2.5
Silica and traces of ox. of iron and alumina,	2.6
Water and a little vegetable matter,	12.3
	100.0

11. *Marl*, (No. 12.) Williamstown; nearly white and very pure.

Carbonate of lime,	89.0
Carbonate of magnesia,	4.2
Silica with traces of ox. of iron and alumina,	1.0
Water and a little organic matter,	5.5
	99.7

12. *Marl*, (No. 13.) Peacham.

Carbonate of lime,	83.5
Carbonate of magnesia,	1.0
Silica and traces of ox. iron and alumina,	4.2
Water and vegetable matter,	10.5
	99.2

13. *Marl*, (No. 14.) Monkton; contains more earthy and organic matters than the others.

Carbonate of lime,	72.9
Carbonate of magnesia,	2.4
Silica with a little ox. of iron and alumina,	11.2
Water and vegetable matter,	13.6
	100.1

As many marls are said to contain phosphate of lime, which greatly enhances their value as fertilizers of the soil, particular reference was had to its detection in the analyses; but the results showed that phosphates, if present, exist in so small a proportion as not to be detected in operating on the quantity of marl submitted to analysis.

14. *Brown Clay*, (No. 15.) Middlebury.

Alumina,	31.2
Silica,	49.7
Iron and traces of manganese,	6.6
Water,	12.3
	99.8*

Claystones. The examination of these concretions shows that they consist of carbonate of lime mechanically involving a somewhat variable amount of clay and silicious matter. A dilute acid readily dissolves the earthy carbonate and leaves the clay unaffected. A small portion of carbonate of magnesia appears to be always present, and the clay contains in addition to silica and alumina a small and variable proportion of oxyd of iron, besides traces of oxyd of manganese. The presence of this last ingredient was always indicated by the green tint due to manganate of soda, which appeared when the clay was fused with an alkaline carbonate, but its quantity was very minute. The separation of the iron and alumina was not attempted as it appeared a matter of little importance.

15. (No. 16.) (Argillo-calcareous.) Ryegate.

Carbonate of lime,	40.2	42.9
Carbonate of magnesia,	2.7	
Alumina and oxyd of iron,	42.3	56.0
Silica,	13.7	
	98.9	

*Carbonate of lime is also present. C. B. A.

16. (No. 17.) Bethel.

Carbonate of lime,	40.9	42.0
Carbonate of magnesia,	1.1	
Alumina and oxyd of iron,	41.7	56.9
Silica,	15.2	
	——98.9	

17. (No. 18.) Pittsford.

Carbonate of lime,	44.3	48.3
Carbonate of magnesia,	4.0	
Alumina and oxyd of iron,	36.3	51.6
Silica,	15.3	
	——99.9	

18. (No. 19.) Rutland.

Carbonate of lime,	44.4	49.3
Carbonate of magnesia,	4.9	
Alumina and oxyd of iron,	32.9	49.7
Silica,	16.8	
	——99.0	

19. (No. 20.) Norwich.

Carbonate of lime,	40.8	48.0
Carbonate of magnesia,	7.9	
Alumina and oxyd of iron,	35.5	52.8
Silica,	17.3	
	——100.8	

20. (No. 21.) Sharon.

Carbonate of lime,	43.3	45.1
Carbonate of magnesia,	1.8	
Alumina and oxyd of iron,	33.2	49.8
Silica,	16.6	
Loss-Water,	5.1	
	——100.0	

21. (No. 22.) Ryegate.

Carbonate of lime,		35.8
Carbonate of magnesia, traces,		
Coarse sand and clay,		64.2
		——100.0

This is an example of a calcareous concretion, embracing sand and coarse earth. The insoluble residue was not submitted to analysis.

22. *Infusorial silica*, (No. 24.) Peacham. This deposit consists almost entirely of silica. It contains, however, traces of carbonate of lime. (Quere, from infusorial shields of the calcareous carbonate?)

23. *Infusorial earth*, (No. 25.) Maidstone. Like the last, silica with small portions of carbonate of lime and vegetable matter.

24. *Chromic iron*, (No. 28.) Jay. The analysis of this ore, gave of

Green oxyd of chromium,	49.9
Protoxyd of iron,	48.96
Alumina with traces of silica and magnesia, (by the loss,)	4.14
	——100.00

100 parts of this ore, yield of neutral chromate of lead, (pure chrome yellow,) 191.2 parts.

25. *Galena*. (No. 29.) Morristown. A portion of lead reduced from this ore, gave a small quantity of silver by cupellation. It was equal to one-fifth of one per centum, which is four pounds of silver to the ton (2000 lbs.) of metal. This quantity will be well worth working, provided the lead is abundant. An assay on another portion of ore, embracing fragments from several specimens to afford an average, will be very desirable, as the general proportion of silver may be greater or less than that afforded by the specimen examined. Probably one pound of silver in a ton of lead would more than repay the cost of extraction, as lead yielding only four ounces to the ton, is said to be profitably cupelled in Great Britain.*

26. (Light green mineral, No. 30.) Plymouth. This is a pulverulent *green malachite* or carbonate of copper. The small brown or purple particles are *vitreous copper ore*.†

B.

Report of S. R. Hall.

To C. B. Adams, State Geologist:

Sir—According to your instructions, I have spent two months, during the past season, in prosecuting the Geological Survey. Of that portion of the time spent in company with yourself, I need not speak, as you have all the facts brought to light.

The remaining part of my time has been spent in the Missisco valley, the northern part of Orleans county, and the northwestern part of Essex, and in the counties of Orange, Windsor, and Lamoille.

*It will be understood that these estimates refer only to the extraction of the silver, not to the cost of the ore, which must be paid for by the lead obtained.—C. B. A.

†Disseminated in very small, delicate portions through dolomite, mostly in thin crusts in the seams of the rocks.—C. B. A.

Having already made you acquainted with the leading facts of scientific interest, this report will be confined chiefly to subjects of economical value.

IRON. A leading object of an excursion into the Missisco valley, was a re-examination of the ores of Iron found in Berkshire, Jay, Troy, and Westfield. The opinion expressed by Mr. Thompson and myself in 1845, of the value of the Hematite of Iron, in West Berkshire, was confirmed. Since that period, veins of ore have been discovered in the northeastern part of the town, bordering on Richford. These were examined with as much care as circumstances would permit. The ore on the farm of Silas P. Dean, Esq. is Red Hematite, of medium quality. The vein is three to four feet wide, in hard Talcose Slate. It has been opened but two or three feet below the surface. The specimens obtained were of about medium quality. The direction of the vein is the same as the rocks in place, and is doubtless a part of the range passing from Broome, Canada East, to Milton, in this State. Mr. Dean supposes that the vein extends through the whole of his farm. There is reason to believe that the ore is abundant, though this cannot be certainly known without opening the vein to a greater depth, and in other places.

On land of Mr. Louis Rosseau, a bed or vein of ore occurs, in some places ten feet wide. This ore, on the surface, appears to have been acted on by the atmosphere, and is very friable. Some pieces were found to be strongly magnetic, and others but slightly so. The ore is seen for twenty rods or more, on the surface. Till the vein is opened, it is not possible to ascertain the comparative value of this ore. I have strong hopes, it will prove very abundant and valuable. Another bed of ore has been opened on the farm of Mr. Joseph Larreau, about one mile from the former. This is strongly magnetic, and is the variety called "shot ore." It has been tested by Mr. Batchelder, of Jay, in his forge, and found to smelt with remarkable facility, and to make the best of iron. It strongly resembles in appearance the best variety of the Peru [N. Y.] ore. The indications of there being a large quantity are less favorable than at either of the other places. This must be decided by more extensive openings. I am inclined to suppose the one at Rosseau's will be found of the same variety, and that both belong to the same vein. The latter is as near as could be ascertained, N. 35° E. of the former, which is about the direction of the strata. The ore on Mr. Dean's farm is about half a mile southeasterly from Larreau's and a mile and a fourth south of Rosseau's mine. These veins are only from one to two miles from Richford Mills. The water power here is adequate for a blast furnace and forges. Should the quantity and quality of these ores prove to be as good as present appearances indicate, their value is very great.

CHROMIC IRON. Since the discovery of a vein of this ore

last year, on the farm of Mr. Farwell, in Jay, it has been found at two other places, one of them on the next lot north, and the other on the next farm south. A line extending from the latter to the former, passes over Farwell's mine. A considerable opening has been made at the south, and at Farwell's mine. The vein at both places is similar in width, and the ore at all, nearly similar in quality. But little opening has been made at the northern locality. The vein is probably as wide or wider than at the other places. There can be but little doubt that the quantity is as large as can be desired, and will be made highly profitable. The ore at the north and central places of opening, has been purchased by Jerre Hodgkins, Esq. of Westfield. The title to the other locality, I was informed, is claimed by him and Mr. Corey, of South Troy.

A vein of Chromic Iron has been recently discovered about one mile southeasterly from the village in South Troy, on the farm of Esq. Pierce, on the east side of the Missisco River. This vein occurs in the eastern range of serpentine, and about 2½ miles south of the magnetic iron ore, from which the furnace is supplied. It is on a high bluff, and conveniently situated for opening to a great depth. The width of the vein is about the same as of that in Jay, and the appearance of the one so nearly similar, it would be difficult to distinguish it. This locality is about two miles north of the small vein on Mr. Miller's farm, Westfield, mentioned in the *First Report.* The Serpentine in the latter place appears on the west side of the Missisco river, owing to an eastern curve in the channel. Miller's mine has been opened several feet the present season, and the vein improves in width. At this place, and at Pierce's mine, I have no doubt, large quantities will be obtained, after adequate openings have been made.

There is reason to apprehend other discoveries of this important mineral will yet be made in the immense ranges of Serpentine which extend from Lowell to Potton, C. E. on both sides of the Missisco river.

MANGANESE. A locality of the silicate and black oxyd of manganese, occurs in the N. W. part of Irasburgh, one mile west of Coventry Village. No opening has been made, and no estimate of the extent can be given. The fact that many fragments have been found as far south as Craftsbury, precisely similar, furnishes the best evidence of an extensive vein. An opening will be made during the autumn, a report of which may be in season for the *Final Report.*

A locality of both silicate and black oxyd of manganese on the farm of Samuel Dickerman, Esq. two miles west of the village of East Topsham, has been examined. This occurs in mica slate, and appears to be extensive. No opening has been made since Mr. D. purchased the farm, many years ago, or within the

recollection of those living in the neighborhood. But it is obvious that some labor had been expended at an earlier period. The ore appears in two places, some thirty rods apart. The vein at each place is five or six feet wide. The quantity is doubtless considerable.

Copper Pyrites. The copper mine at Corinth, mentioned in the First Report, has been re-examined. The most favorable anticipations of its extent, then formed, have been fully confirmed. Instead of a single opening, as then stated, many have been made, for the distance of 200 rods, bearing N. 10° W. and in every instance where the rock has been uncovered, both blue copper in the soil, and pyrites in the rock, have been found. The first opening has been greatly extended across the strata of mica slate, and both iron and copper have been found in every part. On the top of the hill, some 150 rods distant, the vein of copper is more than one foot wide, and no iron is disseminated with it. A considerable quantity of the ore has been transported to Boston, to the works of Mr. Davis. Mr. Barber, who has purchased a right in the mine, being absent on a journey, I was not able to ascertain the per cent. yielded by the ore. This and some other facts will be obtained in season for the Final Report. There can be no reasonable doubt, that the quantity is very large.

Building Stones. The most important rocks of this kind, examined during the present year, are the following:

Syenite, of Ascutney. The rock of this mountain is very compact, and at several places is capable of being advantageously quarried. It is already employed to considerable extent.

Granite. Cushing's ledge, in the easterly part of Pomfret, three miles N. E. of Woodstock village, is one mile in length, and nearly half a mile in width. The quantity is inexhaustible, and the quality good. Its value would be greatly augmented, if it were nearer the track of the rail road, or some good roads. It is on the side, and near the summit of the highest hill in the town.

In Bethel, on the hill between the east and west villages, is a quarry of very beautiful granite, specimens of which may be seen in the magnificent bridges for the rail-road in Royalton. It is easily wrought, and furnishes one of the handsomest varieties of building stone in the state. Another quarry has been opened in the N. E. part of Tunbridge. Not having examined it, I am unable to describe it. It is said to be of good quality and extensive.

Marl. Several extensive deposits of this important substance have been discovered the present season. Of these, one on land owned by Mr. Willey, near Derby Centre, and another in the easterly part of Holland, are among the largest.

The distribution of marl, so extensively in that part of the state, where the limestone is not sufficiently pure for making

good lime, must be regarded as one of the benevolent provisions of the Creator, far the necessities of the community.

Facts of *scientific interest*, which will be found in my journal, need not be given in this place, as they will be more especially appropriate for the *Final Report*.

Respectfully yours,

Craftsbury, Sept. 23d, 1847. S. R. HALL.

C.

Letter from Professor James Hall, on certain Fossils in the Red Sand-rock of Highgate.

Albany, N. Y., September 17th, 1847.

My Dear Sir,

I have only now received your letter of the 10th instant, on my return from a geological excursion. I have examined the fossils and, as far as I can determine they are all of the central portion of the buckler of a Trilobite, with a prominent narrow lobed glabella. The cheeks have been separated at the facial section, so that we have not the entire form of the head. The course of the facial section indicates that it terminated on the posterior margin of the buckler, and the glabella is narrower in front than behind—these two characters are inconsistent with Calymene, Phacops or Asaphus, the common genera, (as well as with several other genera) of our strata, but they belong to Conocephalus and Olenus. I am inclined to regard this fragment as part of a Conocephalus, of which I have not before detected a fragment in our rock. From its isolated character, therefore, I am able to infer little regarding its real geological position. The form known to me most nearly like this one, is in the Clinton group of this state. I regret that more species could not have been found, or that some forms in the preceding strata could not be obtained to compare with others already known.

The meagre information of the two known species of Conocephalus is likewise an objection to any geological inference from the discovery of a species. All we know is that they are found in Graywacke, in Germany, or elsewhere, and the position of Graywacke is too dubious and ubiquitous to be of any importance in such a case.

I regret exceedingly that I am able to give only this meagre and unsatisfactory information, and also that I have not had the satisfaction of seeing the locality.

I shall see you in Boston next week, if I am able to go there, and will there reply more fully to the other part of your letter respecting N. Y. fossils.

I have prepared nothing for our meeting, but am coming to see what others do.

I am very sincerely, yours. &c.

Prof. C. B. Adams. JAMES HALL.

[Two specimens only have been obtained of a shell, which resembles Atripa Hemispherica, of the Clinton group of the New-York system. Prof. Hall informs me that he is disposed to assign both the Clinton group and the Medina sand-stone to one Geological period.—C. B. A.]

D.

Expenses of the Survey.

The expenses from February 26th, to September 26th, of the present year, have been as follows:—

Travelling expenses,	$363.36
Salary of Principal,	466.67
Salaries of commissioned assistants,	155.00
Services of occasional assistants,	173.78
Services of President Hitchcock,	25.00
Apparatus, rent. fuel and light, packing materials, and other expenses of depot,	103.67
Postage and transportation,	35.37
	$1322.85

The estimates for the remainder of the year, up to February 26th, 1848, are the following:—

Travelling expenses,	75.00
Salary of Principal,	333.33
Salaries of commissioned assistants,	125.00
Services of occasional assistants,	53.76
Apparatus, rent, fuel and light, stationary, and other expenses of depot,	40.00
Postage and transportation,	50.00
	$677.08
	$1999.93

The estimates, for each of the two years required for making out the results of the geological survey, are the following:—

Travelling expenses,	$150.00
Salary of Principal,	750.00
Services of assistants,	200.00
Clerk hire,	200.00
Apparatus, rent, fuel and light, stationary, and other expenses of depots,	200.00
Chemical analyses,	100.00
	$1600.00