E. Emmons Jr. del.

Endicott Lith.

PLATERSKILL COVE.

Natural History

OF

NEW YORK.

BY AUTHORITY.

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AGRICULTURE

OF

NEW-YORK:

COMPRISING

AN ACCOUNT OF THE CLASSIFICATION, COMPOSITION AND DISTRIBUTION OF THE SOILS AND ROCKS,

AND THE NATURAL WATERS OF THE DIFFERENT GEOLOGICAL FORMATIONS;

TOGETHER WITH A CONDENSED VIEW OF THE

CLIMATE AND THE AGRICULTURAL PRODUCTIONS OF THE STATE.

BY EBENEZER EMMONS, M. D.

VOLUME I.

ALBANY:
PRINTED BY C. VAN BENTHUYSEN & CO.
1846.

TO HIS EXCELLENCY SILAS WRIGHT,

Governor of the State of New-York.

SIR,

THE present volume, the completion of which is in a great measure due to your special indulgence (in granting a prolongation of the time originally stipulated), contains a general account of the soils of the State, their composition and distribution, and their relations to the underlying formations. Although the work thus far has been the result of much labor, still I can but barely hope that its execution may meet your approbation, and subserve the purpose for which the Survey was ordered by the Legislature of New-York.

Your obedient servant,

E. EMMONS.

ALBANY, December 30, 1846.

PREFACE.

THE volume which is now submitted to the agriculturists of New-York, contains the results of my investigations respecting the soils of the State. Its execution has occupied my time for nearly four years; and on reviewing my labors, I cannot but hope that something has been done, which will advance the interests of the farmer.

One of the first inquiries which engaged my attention, was the classification of soils; a subject which is confessedly one of great complexity, and which has never been exhibited in an intelligible and useful form, and, I may add, is probably not destined to a result so desirable in itself. As the geological survey of the State had just been finished, and as the works containing the information respecting the rocks then known were so generally distributed, it was deemed proper to propose a classification of the soils, which should be founded upon a geological basis. Accordingly a reconnoisance of the State was made, with the view of ascertaining whether a classification founded upon geology would be useful. The result of this examination led me to hope that useful ends would be gained by a classification thus founded, and I have therefore proposed one in the first pages of this report, which I consider applicable to the soils of this State.

In order, however, that this plan may be increased in usefulness, I have given an epitome of the geology of the State, and have constructed maps and sections designed to aid the farmer and student in acquiring a knowledge of agricultural geology. It might have been desirable to increase the number of illustrative sections and maps; but, upon the whole, it seemed better at present to fall short of what would be required for a full illustration of the report, than to extend them too far, as might be judged by many persons whose opinions I should most certainly feel bound to respect. Occasional illustrations in lithograph have been given of the features of various parts of the State, in which the characters of the natural vegetation have been introduced. It is not pretended that these illustrations were absolutely necessary to the usefulness of the report, still it is believed that the value and interest of the work is thereby materially enhanced.

In the progress of this work, numerous subjects came up for investigation; and such must always be the case in a science which has so wide a field as agriculture. Among these subjects of investigation, the local temperatures, the annual amounts of rain, the length of the seasons in the different districts, the times of harvest, and the various accidents to which vegetation is occasionally exposed from contingencies of the weather, have received a share of my attention. Of those questions which all will regard as practically useful, the determination of the composition of the rocks that give origin to the soil is one which has occupied my particular care. A similar remark might be made respecting the composition of the waters of the different geological formations, though it must be said that want of sufficient time has prevented so full an investigation of this question as was desirable. As fertilizers of the soil, the shales, limestones, marls, peats, etc. have constantly occupied my attention; but I have devoted more time to the consideration of the soils themselves, than to the other subjects of inquiry.

At the time I began this work, the utility of analyzing soils was regarded by many as questionable, and perhaps the same opinion is still entertained to some extent. My own views at first coincided with the opinions of those who looked upon the utility of the analysis of soils as somewhat doubtful; but on making the reconnoisance before referred to, I became convinced, that so far as this State was concerned, many beneficial results would follow from a faithful questioning of the soils by analysis. I accordingly commenced the work, and have pursued it faithfully up to the present time; and I must say that my views in favor of the utility of the undertaking have rather been strengthened by the results obtained, more especially by those which appear in the latter part of this volume.

I have kept in view, during the whole progress of the work, the relations of the soils to the rocks. I cannot, however, avoid observing that the subject is still open to investigation, and that much yet remains to be done in this field of inquiry. A want of time and means has cut short, to a certain extent, the plan I had proposed to carry out. Indeed it has been impossible to visit more than a few of the most important places in the State, for the purpose of collecting the necessary specimens of soil; and those who are practically acquainted with the processes of analytical chemistry, and who are aware of the great care requisite to secure reliable results, will not be surprised that many of the inquiries are but partially completed.

It will be seen that I have laid some stress upon the division of the State into maize (or indian corn) and wheat-growing districts. The distinction may be one of little importance, and some may regard it as useless; still I believe that the actual constitution of the soils, and of the rocks from which they are derived, will bear me out in the distinction itself.

The origin of the phosphates has been with me an object of considerable research, in which I trust I have obtained some satisfactory and useful results. I believe this is the first attempt, made in this country, to determine the rocks which contain phosphates, and distinguish them from those that do not. I consider the inquiry an interesting one, which ought to be further prosecuted.

It may appear to some that I have devoted too much time and space to the consideration of the Taconic system. It must be remembered, however, that in giving an epitome of the New-York rocks, it was necessary that the rocks of this system should be noticed also; and inasmuch as the question respecting their age was one which had occupied our most distinguished geologists, and was in itself highly interesting in many points of view, I deemed it proper, considering the impulse which the State of New-York has given to geological inquiry, to press the matter to a conclusion, by settling definitely the era of the rocks of this system. The system belongs pre-eminently to New-York : conflicting views prevailed concerning it; and it was thought justifiable to make a strenuous and final effort for the settlement of the question.

To show that I have not been indifferent to the utility of my labors, I may state that I so divided my time as to secure the greatest economy. The summer, being the only season when outdoor observations can be made, has been spent mostly in the field, and the winter in the laboratory. In the field, I have been assisted by my son, a part of his expenses being defrayed by myself. In the laboratory, Mr. SALISBURY, and L. CHANDLER BALL, Esq., were occupied steadily and unremittingly for three hundred days, without incurring expense to the State. Several other gentlemen have also given me very essential aid in analysis, and without expense to the State. About five hundred days work in the laboratory have thus been rendered gratuitously. During the whole time this assistance was rendered, my own presence was necessary as a matter of course.

The preceding statement, it is hoped, will be satisfactory to those who inquire how the four years spent in the survey have been occupied. One remark further seems to be called for : At the commencement of this survey, I engaged to complete it in one year. I then hoped, that with the aid of individuals interested in the success of the undertaking, so much might be accomplished as would afford general results of very considerable value. My task, however, as it now appears, was not truly defined in that engagement; and finding myself afterwards sustained by men whose opinions could not but be respected, and even by instructions which were obligatory upon me, much more was determined upon when the field was partially surveyed; for if the agricultural interest is not one of paramount importance, I have mistaken the nature of the duties in which I have been engaged. Besides, the whole matter was stated to a committee of the Legislature in 1845, to whom all the engagements which had previously been entered into with the State were submitted, and were by them examined and investigated, and it was by their unanimous recommendation that the survey has been in progress for the last two years.

The second volume of the present work is in course of preparation, and will contain, among other things, an account of the composition of the ashes of the different cultivated vegetables; a description of the several varieties of the cereals which seem to be best adapted to our climate, and a list of the principal fruits which reach perfection in the different districts.

The division of the work into two volumes, though by no means intended when it first went to press, has been decided upon in consequence of an increased amount of matter, which has accumulated during its progress, and which, if bound in one volume, would make it too thick for convenience : inasmuch, too, as no additional expense to the State will arise from the measure, but, on the contrary, something will be gained; the expense of binding a volume being less than the price for which it is sold to counties and individuals.

In conclusion, I tender my thanks to those who have assisted me in this survey. Mr. G. H. Smith of Rochester, and Mr. W. M. Smith of Manlius, are entitled to my acknowledgments for their services in the winter and spring of 1846. Messrs. G. Geddes, H. S. Randal and L. F. Allen, have assisted me in many ways. David Thomas is entitled to a similar acknowledgment; for I have not hesitated to ask his advice on many doubtful questions, and have always been kindly and frankly responded to. I have already given the names of the two gentlemen who have been so efficient in the laboratory, and who are still zealously engaged in chemical analysis. Mr. J. Crary, a young chemist of Washington county, has also aided me considerably in the work of analysis. To Mr. J. Paterson, who has superintended the proof-sheets, the volume is in a great measure indebted for its general correctness.

E. EMMONS.

Albany, December 30, 1846.

TABLE OF CONTENTS.

CHAPTER I.

CHAPTER II.

TOPOGRAPHICAL SKETCH OF THE STATE.

CHAPTER III.

CLIMATE AND TEMPERATURE OF THE STATE.

CHAPTER IV.

AGRICULTURAL GEOLOGY.

CHAPTER V.

THE TACONIC SYSTEM.

CHAPTER VI.

THE NEW-YORK SYSTEM.

CHAPTER VII.

SOILS OF NEW-YORK.

REPORT

ON THE

AGRICULTURE OF THE STATE OF NEW-YORK.

CHAPTER I.

PRELIMINARY OBSERVATIONS.

I ENTER upon the work of preparing the Report on the Agriculture of the State with feelings of deep anxiety and concern. The importance of the subject, the difficulties which surround it, the extent of territory, and the very limited time granted for the accomplishment of my labor, are considerations which, in their individuality, are of great moment, but when taken collectively, become so overwhelming as almost to induce me to shrink from the task. But these are not all. A large and highly intelligent community expect much from this part of the survey. A branch of industry, admitted by all as the most important, is expected to be highly benefited by a series of practical observations, and of chemical examinations of the soil and its products. A disappointment of these expectations, whether owing to a disproportion between the magnitude of the undertaking and the time allotted for its achievement, or to the incapacity of the Reporter, may throw discredit upon the enterprise, and thereby not only exert an injurious influence upon the science of agriculture, but serve also to discourage the renewal of any similar attempt, which, under more favorable circumstances, and in abler hands, might accomplish all, perhaps more than, the community of agriculturalists now anticipate. Leaving, however, all forebodings behind, I will proceed in my mission with as much diligence and despatch as possible. I shall, in the first place, give a general plan of the report. This will acquaint the reader with the kind of work in which I have been employed; a species of information which I suppose him desirous of obtaining.

The first subject upon which I shall treat is the topography of the State, or those natural divisions which bear so strongly upon its agriculture. In this connection, I shall furnish all the important facts relating to temperature. These are both important subjects, and necessary to be fully understood for pursuing understandingly any system of farming, or for determining upon the introduction or the necessity of rejecting a particular crop. Especially is it essential that all those who lead public opinion in matters of farming and production, as the officers and influential members of state and county societies, should know the country and its capabilities; and these capabilities can not be properly determined without an acquaintance with the surface of the country, with its exposures, its height above tide water, and its mean annual temperature.

In the second place, I propose to treat of the rocks and their position, both geologically and geographically. The rocks are the parents of the present soil. It may not be that a single rock has produced an extensive soil of a particular character, but a combination of them has undoubtedly done so; and their debris will be found spreading widely, and giving character to extensive tracts of country. Admitting this view, certain inquiries would naturally grow out of it. What is the character of the soil, derived as we say from certain parent rocks? What are its elements? What changes will it undergo by cultivation? To what crops is it adapted; and when it loses its fertility, will the parent masses furnish the means of regenerating it, or of bringing it back to its original fertility? Many other questions of a similar nature would come up; but these are sufficient to show that a knowledge of the rocks, the parents of the soil, is important in agriculture.

There are still other questions in geology which are full of importance to agriculture, as the following: How do the rocks lie in their beds; are they vertical, inclined or horizontal? These are important points in the art of draining; and in some localities, it is absolutely impossible to drain without this knowledge. In this connection, too, I might speak of fractures or dislocations, and of trap dykes; as a knowledge of their existence is also important in the practice of draining.

After having treated of agricultural geology, as it is termed, I shall proceed to the consideration of vegetable and animal products, their elements and their origin; and of the process of nutrition and assimilation, subjects usually termed *physiological*.

Lastly, it is my design to state what is known of the soils of New-York, their composition, and their adaptation to particular kinds of husbandry. Probably few States possess a greater range of soils, or are so well adapted to so great a variety of productions. In fact, taken as a whole, it would be difficult to mark out upon the terrestrial globe a spot as large as New-York, whose capabilities of production come up to her standard; whose general relations are so important; where there are so many great centres of business; where there are so many and such large channels of wealth, and all flowing to one metropolis; or, in fine, whose natural resources can come up to the full measure of this commonwealth.

CHAPTER II.

TOPOGRAPHICAL SKETCH OF THE STATE.

TOPOGRAPHICAL OUTLINE. DIVISION OF THE STATE INTO AGRICULTURAL DISTRICTS : NORTHERN AND SOUTHERN HIGHLAND DISTRICTS; EASTERN DISTRICT; MOHAWK AND HUDSON DISTRICT; WESTERN DISTRICT; SOUTHERN DISTRICT; ATLANTIC DISTRICT. REFERENCE TO PLATES II., III. AND V. LETTER FROM D. THOMAS.

TOPOGRAPHICAL OUTLINE.

If variety of surface and climate favors multiplicity of productions, then may the State of New-York be said to be fitted by Providence for that end. Stretching from north to south over four and a half degrees of latitude, and rising to an elevation varying from the sea level to five thousand feet and upward, a wide range is furnished for a multiplicity of species, both in the animal and vegetable kingdoms. She extends her arms through a large portion of the temperate zone; and by her elevated northern highlands, ranges closely upon alpine regions, where the larch, spruce and fir dwindle to mere shrubs, or in fact lose their identity as it were in dwarfish miniature trees. It is difficult to draw distinct and sensible boundary lines between regions which shall be distinguished both by dissimilar vegetable growths and animal forms; yet we may see that large areas do exist where climate and soil are better fitted for certain productions than others, although they are so blended that the boundaries are obscured by a gradual coalescence. I leave out of view here what seem to be mere local peculiarities of certain districts, which, in consequence of frosts out of season, render certain crops uncertain and precarious, such as that of indian corn in some parts of St. Lawrence and Jefferson counties, where the mean temperature of the seasons is sufficiently high for its culture. The same may be said of certain fruit trees, as the apple and plum, which, though they may flourish for several years, are yet liable to be destroyed by an unseasonable frost. Many minor districts have their peculiarities, which are rarely taken into the statistics of climate, and which are overlooked in general views.

DIVISION OF THE STATE INTO AGRICULTURAL DISTRICTS.

New-York may be divided into six agricultural districts, each of which has a few characteristics sufficiently well marked to establish a peculiarity, and distinguish it as a separate agricultural region.

1. The Highland districts, comprising the Northern and the Southern highland districts;
2. The Eastern district, which approaches the Hudson river, with its western boundary running parallel to the same;
3. The Mohawk and Hudson vallies;
4. The Western district;
5. The Southern district; and
6. The Atlantic district.

Without placing much stress upon the importance of this subdivision, I barely remark that there are geological features belonging to each, which can not be disregarded, and which will be given to the reader in the proper places. It is now my design to state the peculiarities which belong to surface only, or the facts relating to elevation and depression, or what would more immediately arrest the attention of a traveller passing over those particular districts.

I. The Highland districts are widely separated from each other, but possess characters in common.

1. The Northern highland district is bounded north by the parallel of 45°; on the northeast, it extends to Rand's hill in Clinton county; on the east, it is bounded by Lake Champlain from Trembleau point south to Fort-Ann; on the southeast and south, by a line running from the latter point southwest to Littlefalls, southwest and west by a line running from Littlefalls to Theresa falls on Indian river, and on the northwest by a line from the latter place to near Chateaugay corners. The space included within these boundary lines is an irregular polygon, and embraces formations belonging to the primary divisions or classes. The soil is generally derived from granite and gneiss; is thin upon the higher grounds, but of sufficient depth in the valleys, and is every where covered by a black vegetable mould. But what distinguishes this district from all others, is its height above tide, and the multitude of its sharp peaks and ridges. Its greatest height is near the sources of the Hudson, Ausable, Racket, Black and Mohawk rivers, all of which rise as it were upon the same table land, but are destined to distant portions of the State, and to be lost in waters in opposite points of the compass. This district therefore slopes in all directions from a culminating point, is steeper upon the east than upon the west, and is the great reservoir from whence a large portion of the State is watered. The highest point exceeds five thousand feet, which is gained at Mount Marcy in the Adirondack group, situated about forty miles west of Port Henry on Lake Champlain.

This region is of but little agricultural interest at present; is entirely clothed with forest, a large proportion of which is spruce, fir, tamarack and pine, intermixed with poplar, white birch, red and black cherry, beech, maple, ash, black oak, and, in more favored exposures, bass, butternut and hickory. Ascending the highest summits, we find an alpine region, where reindeer-moss and other lichens abound, and snow remains until midsummer, and where the small pools of water upon the rocks freeze every night during the year.

This region is at least one hundred miles long and seventy or eighty broad. The table land from which the individual mountains spring, is from fifteen hundred to two thousand feet above tide. The ascent is gradual from all sides, and in fact hardly perceptible, and the traveller at the base of these peaks does not suspect that he has already overcome one-third of their height. This highland district, in its present condition, sheds a succession of powerful influences, partly beneficial and partly injurious, upon the vegetation of the adjoining districts. The beneficial influences are derived from the abundance of water which the district affords: it furnishes the head-springs which irrigate one-third of New-York. The injurious influences come from the reduction of temperature, the cold snowy winter, and the unseasonable frosts of the earlier and later parts of the summer. Testing the capabilities of it as an agricultural district, it is found that oats, peas, barley, rye and wheat may be raised. The two first may be regarded as constant crops; the others thrive best the two first years after clearing. Indian corn, of the varieties used as far south as the metropolis of the State, is greatly endangered by frosts, and is rarely ripened. It is not owing to any defects in composition of the soil that this district is comparatively unimportant, but to the low and variable temperature. The hills, however, will afford good pasturage, and herds of cattle and flocks of sheep may one day give life and animation where the silence of the day is broken only by the rustling of the wind through an unbroken forest.

2. The Southern highland district possesses many of the same characters as those of the northern. Being, however, of less extent, and far inferior in height, it exerts comparatively little influence on the surrounding country. This district is known as the Highlands of the Hudson, the Hudson river having found a passage through them. It embraces parts of three counties, Rockland, Putnam and Westchester. The highest elevations are unsusceptible of cultivation, from the rough broken state of the surface, and the want of sufficient covering to the projecting rocks. At the base, however, the surface, although yet frequently broken, is productive, and not subject to unseasonable frosts. The mountains and hills can not be said to stand upon an elevated table land, but rise immediately from a platform whose height is nearly upon the sea level. In this particular, therefore, the southern highlands differ from the northern; and in consequence of their limited area, they require only a passing notice as an agricultural district.

II. The Eastern agricultural district is bounded by the States of Connecticut, Massachusetts and Vermont, and extends to the immediate skirts of the Hudson valley on the west. The eastern boundary referred to, however, passes through the district, and bounds it only so far as New-York is concerned. It really extends to the foot of the Green mountain range.

The features of this district differ from those of the preceding, where we find bold abrupt mountains rising in peaks, and presenting, on one side at least, steep or perpendicular precipices; while here the mountains slope moderately, rise in long narrow ridges, and present but few inaccessible cliffs. The steepest slope is generally too upon the northwest side. We find also a contrast in the character of the soil, which is deep, covers the tops and sides of the hills, and gives them a rounded form, which renders them susceptible of cultivation to their tops. The elevation in New-York does not exceed fourteen or fifteen hundred feet, and by far the greater proportion of the surface is not much above seven or eight hundred feet. The greatest elevation in Massachusetts is three thousand and five hundred feet above the sea level.

But the soil and surface of this district differ no less from those of the preceding, than does its system of rocks. This system, which may be said to spring out, or to be derived more immediately from, primary rocks, partakes necessarily of an intermediate character, bearing something of a primary aspect, but at the same time being not so far removed from the newer sedimentary rocks as to be mistaken for primary. The composition of the members of this system, too, is quite remarkable and important. We find magnesia to be a common element; and we imagine that we see in their composition the reason why indian corn, one of the best of products, is so much at home upon the soils of the gentle slopes of this system. At any rate, in no other district is this crop so perfect, so sound and rich, as in Dutchess, Columbia, Rensselaer and Washington counties. Comparing this crop in the Eastern district with that of the Western, we unhesitatingly give preference to the former, as being more thrifty and sounder in the kernel, and better filled out. There is a limit, however, at which maize ceases to ripen in this district. For example, along the Taconic range between Massachusetts and New-York, at the height of about one thousand feet above tide, it dwindles to a short slender stalk, and yields but small tapering ears. This limit is often marked by a line of frost during the cold months, to which it very frequently descends, forming a distinct icy line of congealed vapor upon the forests, and upon the trees of the cultivated fields.

The Eastern district is a belt extending from the Sound in Westchester county, to the head of Lake Champlain at the north extremity of Washington county. It embraces a large proportion of the four counties above enumerated; and though narrow and long, it is very constant in its character and features, as well as productions, through its entire range.

This district resembles that of the Hudson and Mohawk, and perhaps both might be included in one. The taconic and black slates form, by their decomposition, a soil closely

HUDSON RIVER AND [illegible]

approximating to that of the shales of the Hudson and Mohawk valleys. When, however, we take in the eastern formations towards the base of the Hoosic mountain range, with the valleys of the Hoosic and Housatonic, we find a soil and surface sufficiently distinct to merit the division I have proposed. The widest difference is then to the east; while at the west, the two districts are merged into each other.

Plate V. gives a panoramic view of the hills of this district, as seen from the Helderberg range on the west. The fore-ground is occupied by the limestones of this range; the middle, by the Hudson river slates and shales, and the back-ground by the long range of slate hills belonging to the Taconic system. The valley of the Hudson lies in the middle ground, and is bounded by those slates.

III. The Third district comprises the valleys of the Hudson and Mohawk. It is less regular in its shape than the other districts, and besides is not confined wholly to that territory which is usually considered as belonging to these valleys. Thus, at the commencement of the Southern highlands, it diverges from the river to the southwest, and passes through Orange county into the State of New-Jersey. Towards the northwest, it passes beyond the valley of the Mohawk into Jefferson county, by the route of the Black river.

In its characters it is closely related to the preceding. Its slaty or shaly rocks, and sandstone and limestone beds, furnish, when mixed, a soil much like that of the Eastern district. There is, however, as already remarked, more alluvial matter, broader meadows, and a less undulating surface. Beneath the bottoms of the Hudson and Mohawk, there reposes a stiff calcareous clay; and departing a little from these rivers, and ascending their sloping banks, we find sandy plains, which, however, are underlaid with the same stiff clay, a marine deposit of a modern date. No part of this district rises into mountains. Steep bluffs are common, but rarely exceed three hundred feet in height. As an agricultural district, it is important; but it has been longer cultivated, and hence is more exhausted than either of the districts which have been named.

The valley of the Mohawk at Amsterdam is pictorially illustrated in Plate II. The steep furrowed banks of clay with a scanty vegetation, are seen upon the left; the islands in the Mohawk covered densely with willows, and the partially wooded hills, form the back ground. In the foreground, the peculiar appearance of the elm so common on the banks of the Hudson and Mohawk, is well represented, giving to the landscape a striking feature. Flats and shallows are constantly recurring in the Mohawk, sometimes forming ripples which are always covered with water; at other times, low islands, which support only willows and alders, but occasionally are sufficiently elevated to form fertile and beautiful meadows, adapted either to grass, maize or broomcorn.

IV. The WESTERN DISTRICT borders the Mohawk on the south, and may be bounded north by a terrace extending parallel with the Erie canal, and commencing a few miles west of Littlefalls. Instead of following the Erie canal, it diverges to the northwest, and strikes Lake Ontario near Oswego. The south boundary passes west through the southern half of Seneca and Cayuga lakes, and terminates upon Lake Erie.

The surface of this district never rises into high or steep hills. It is gently undulating, or rises in heavy swells. It is often traversed by deep cuts, forming deep narrow ravines; a peculiarity which arises from the slates and shales which are scored by the streams and rivulets of the country. Some parts of the country, however, are elevated, rising thirteen or fourteen hundred feet above tide, particularly in the range passing through Cherry-valley and Pompey. The surface of the district is undulating and often level; and we pass over tracts embracing large farms, where it is difficult to determine by the eye alone in which direction the surface slopes; besides, it embraces some extensive marsh lands, which are probably irreclaimable.

Plate III. is a view from Mount Hope, three miles south of Rochester. The city appears in the back part of the middle ground. In the open fields stand the superb elms of the deep and rich clay soil peculiar to this district. They are the only remains of the great and noble forests which have fallen before the axe of civilization in the last half century. They run up in an unbroken shaft near one hundred feet, where they at once form a heavy dense head. They are in strict contrast with the elms of a second growth in the valleys of the Mohawk and Hudson, whose trunks are thickly covered with slender limbs, and their heads formed of long pendulous branches. They especially flourish in those deep stiff clayey soils that are rich in potash. Vegetation is an index to the character of the soil. Elms of the same character abound upon the flats of the Black river, where the subsoil is a clay.

The western district is the great wheat-growing district of New-York. It will be understood that the lines of demarkation are not fixed. Wheat is produced in all the counties of the State, or in all the districts: the west differs from the others in being better adapted to this grain. As it regards the southern limits of the wheat district, I take the liberty of introducing a communication from DAVID THOMAS, which contains some excellent remarks.*

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* LETTER FROM D. THOMAS TO E. EMMONS.

GREATFIELD, near AURORA. 11 Mo. 18. 1844.

On my return from Philadelphia about a fortnight ago, I found thy favor of the 22d ult. It ought to have been answered immediately, but I have had many things to distract my attention; and even now, I apprehend that my remarks must be of very little value.

I cannot observe any thing to object to, in thy arrangement of the State into districts, unless it be that their distinctive traits are more geological than agricultural; and I may be better understood by asking if our southern tier of counties differ essentially in agricultural products from thy three first districts?

I think it would be difficult to draw the southern boundary of our Wheat District; and at best it must be rather a crooked line. Generally, it is good wheat land as far south as the detritus from our limestone formations has been

PLATE III.

V. The SOUTHERN DISTRICT is confined mostly to the southern tier of counties, lying immediately north of the Pennsylvania line. I do not restrict it to this range, however: it properly extends northward so as to embrace the Catskill range, with parts of the counties of Delaware, Greene and Otsego.

In height, this district attains a rank next to the Highland. The Catskill mountains rise to an elevation of four thousand and fifty-eight feet; and the range of southern counties rest upon a platform, which, if unscarred by aqueous action, would rise uniformly to the height of two thousand feet. But this portion of New-York, which to the traveller passing east and west appears so mountainous, is merely the effect of aqueous and other atmospheric agencies. No internal force or power has raised locally this section above the Western district; but the strata once piled up in increased thickness over and above the upper limestones of the Helderberg, have, by the long continued and destructive action of rivers and large streams, been in many places furrowed through their entire depth for several miles in width, and thus the surface remains impressed with a mountainous aspect or contour. The directions in which these streams flow, or have flowed, determine the

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abundantly spread; for doubtless thou art aware that the current which swept over this country to k a southerly direction. Wherever the slate rocks were exposed to its action, a portion of them is mixed with the soil; and near such localities the land is generally less favorable* for wheat. Thus the Owasco hill in the east part of Venice is less calcareous in its character than the district lying westward. Perhaps the north bank of Salmon creek near Ludlowville, is the southern boundary of the wheat district in this county; although good wheat is grown on some farms as far south as the head of the lake, and possibly farther.

About twenty-five years ago, I travelled across the mountains to Philadelphia, and had good opportunities to observe the drift of our rocks in that direction. It evidently grew scarcer as I advanced; and the fragments became more worn and rounded in their progress, forming a less and less proportion of the diluvial formation. This appearance continued into Pennsylvania about twenty miles beyond the State line, and there every trace of our rocks disappeared.

I may further remark that the people residing on this part of the Susquehanna used to supply themselves with lime by gathering and burning small fragments of rounded stone from the shores, much of it not larger than gravel; and which doubtless were swept from this district. My intelligent host at Sheshequin told me that but little or none of this drift was found below them, but up the river it was abundant in places. I had made similar observations on former journies.

Another circumstance may be mentioned in connection with these remarks: The mountains of Pennsylvania below Sugar creek abound with the broad-leaved laurel (*Kalmia latifolia*) in a greater degree than I have observed in any other district; but on coming north into the drift of our rocks, the laurel disappears, except in some particular localities. Thus, in a sandstone on the side of a hill about a mile north of Ithaca, where I observed no traces of lime, this beautiful shrub was growing well; while in my garden, every attempt to prolong its existence for more than a year or two, has proved abortive. It has doubtless been *poisoned* by the lime naturally in the soil.

Without examining the country with a special view to the southern boundary of our wheat district, we should be liable to much error in drawing that line; but yet it is probable, as I have already mentioned, that Salmon creek below Ludlowville, and the outlet of the Crooked lake below Pennyan in Yates county, would form parts of such a line. Probably through Seneca county, it ought to curve northerly around some of the high land which lies between the Cayuga and Seneca lakes. West of the Crooked lake, however, I am not acquainted, except that the country appears more broken, with higher hills; and therefore perhaps the line ought to bend more to the north.

DAVID THOMAS.

*Because it is less calcareous.

direction of the ranges of mountains, hills and valleys. These ranges therefore differ essentially in their mode of formation from those of the Highland or Eastern sections; the latter having been occasioned by an elevatory force, which has raised them up above the surrounding levels, while the former are due to agencies of depression and abrasion. We have, however, elements which assimilate the climate in each.

In this district, also, the nature of the formations has determined the nature of the surface, as well as that of the soil and its productions. The limestones are discontinued as well as the limestone shales. This element, therefore, so essential to some crops, is not so abundantly furnished as in the lower rocks. Not that it is entirely absent; for most rocks, although they may not effervesce with acids, will furnish lime on analysis. The adaptations, therefore, of the Fifth or Southern district, are of a different order, and not less valuable than those of the Western or Eastern. The pure streams which flow from the siliceous rocks render the pastures green and fresh, the grass sweet and nourishing, and impart health and activity to the flocks and herds which tenant the glades and valleys.

VI. The ATLANTIC DISTRICT comprehends Long island. It is a gift from Ocean's waves, or from Neptune's hand: sands washed from the deep by waves from the broad sea breaking upon the skirts of land, and casting up the debris of a wasted continent. It stretches far away in a southeast direction, in the form of an immense ridge of sand and drift; or, in more common language, is an alluvial formation of a very porous character. It rises three hundred feet above the sea. It has an indented shore; and by constant nursing, its soil is productive and easily tilled. Its position makes it a mean term between the north and south. It is the grand rendezvous for birds of passage. Here they resort from the arctic regions, and find a retreat from the pinching frosts of a northern winter; and from the tropics, to escape a burning sun, and find protection from the heats of summer.

The maize which is cultivated here, is intermediate between southern and northern corn, the length of summer permitting a larger variety than central New-York. The depressing agents are winds loaded with vapor. Exposed places are less productive than those which are sheltered. Hence, the south side, being directly exposed to the Atlantic gales, shows a more barren aspect and a more shrubby vegetation than the northern side of the island, where the slope of the land defends it from those depressing effects.

CHAPTER III.

CLIMATE AND TEMPERATURE OF THE STATE.

INQUIRY INTO THE LAW OF VARIATION OF TEMPERATURE ARISING FROM DIFFERENCE OF ELEVATION, AND FROM DIFFERENCE OF LATITUDE. DIVISION OF THE STATE INTO SIX CLIMATERIC REGIONS: LONG-ISLAND REGION; REGION OF THE HUDSON VALLEY; REGION OF THE MOHAWK VALLEY; REGION NORTH AND NORTHWEST OF THE MOHAWK VALLEY; REGION SOUTHWEST OF THE MOHAWK VALLEY; WESTERN REGION. TABLES EXHIBITING THE CALCULATED AND OBSERVED TEMPERATURES, THE MEAN AND EXTREME TEMPERATURES, AND THE FORWARDNESS OF THE SEASONS, AT VARIOUS LOCALITIES IN THE SIX REGIONS.

THE following article upon the climate and temperature of the State of New-York has been drawn up at my request by Mr. JAMES H. COFFIN, a Tutor in Williams College. I was desirous to present the public with the most accurate results that could be obtained; and from the ability with which Mr. Coffin has always treated these and other subjects appertaining to meteorology, I was confident I could not engage more competent assistance. He has given his communication in the form of a letter, and I have deemed advisable to present it unaltered.

LETTER FROM J. H. COFFIN TO E. EMMONS.

WILLIAMS COLLEGE, September 4, 1843.

At your suggestion, I have devoted some thought to the climate of the State of New-York, and send you the results, though I do not expect that you will find much that is new or valuable in the article. The data from which they have been deduced are mostly contained in the valuable and voluminous collection of meteorological observations published annually in the Report of the Regents of the University of the State. Embracing as they do returns from fifty-eight different localities, in various parts of the State, and scattered over every variety of hill and dale, they must indicate pretty fairly the meteorology of the State in reference to the facts observed, though it is to be regretted that the observations do not extend to a greater number of facts.

The *mean* temperature of these places for seventeen years (so far as reported) ending with 1842, was 46°.49; but the relative temperature of different sections of the State, while it depends chiefly on the latitude* and elevation, is modified in some degree also by a variety of other circumstances, such as the situation in regard to the sea, or other large bodies of water, both as it respects proximity and direction; the configuration of the surface, whether level or hilly, and the position and slope of the hills; the nature of the soil, and the extent of cultivation in the surrounding country. And before proceeding farther, it becomes necessary to investigate briefly the laws by which we shall be guided in relation to the three main circumstances mentioned above; so that having made a proper allowance for these, we may see more clearly the effect of the others.

That the temperature of the air diminishes as we ascend, is a fact familiar to every one; but the rate of decrease, especially where the slope of the country is gradual, is by no means so well ascertained. The experiment was tried at Paris by Gay-Lussac, who rose in a balloon to the height of nearly 23,000 feet, and found the difference in temperature to amount to 1° for every 316 feet of ascent. The mean of two other similar experiments, tried one at the same place and the other at Rodez in the southern part of France, each at a height of a little less than 12,000 feet, showed a decrease in temperature of 1° in 400 feet. Mr. C. F. Durant has kindly furnished me with quite a number of observations of the same kind, taken by him in seven different ascensions in a balloon, from New-York, Albany, Baltimore and Boston, in the years 1831, 3 and 4. The height at which they were taken varied from 1500 to 8000 feet. Taking twenty of his observations, which are capable of being arranged for comparison in twelve pairs, I find the decrease of temperature to be 1° in 425 feet. If, however, we reject the comparison of two pairs of observations, which show great discrepancies from the rest, and which appear by the circumstances in which they were taken to be entitled to less confidence, the result is 1° to every 370 feet of elevation.

From numerous observations made by Humboldt among the Andes and Cordilleras, he deduced the rate to be as follows, viz: For the first 1000 French metres = 3281 feet, 1° for every 319 feet; for the second, 1° in 538 feet; for the third, 1° in 443 feet; for the fourth, 1° in 250 feet; for the fifth, 1° in 331 feet; and for the whole on an average, 1° in 351 feet. In a single observation taken on Chimborazo at the height of about 19,300 feet, the difference in temperature was 1° in 399 feet. The mean of six pairs of simultaneous observations on the Alps and the plains below, showed a diminution of 1° in 262 feet; one on the Peak of Teneriffe and at Orotava below, showed 1° in 412 feet; one on Mount Etna and at Catania, 1° in 312 feet; the mean of twenty-one on the Pyrenees and at places below, 1° in 305 feet; the mean of seven taken at Clermont in France and on elevations in its vicinity, 1° in 267 feet. Twenty-eight simultaneous observations have

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*Several recent writers reject latitude as one of the elements of temperature, but, as it seems to me, unphilosophically.

been lately taken with great care at the Grey Lock Observatory on Saddle Mountain in Massachusetts, and at Williams College. The distance in a direct line between the two stations is about $5\frac{1}{8}$ miles, and the difference in level 2767 feet; the lower station being about 800 feet above the level of the sea. The observations were taken at intervals of two hours from five o'clock in the morning till nine in the evening, and continued on three successive days. The mean result shows a diminution in temperature of 1° for every 337 feet of ascent.

The above are all the direct observations that I have been able to obtain to determine the law in question;* and arranged in tabular form, they stand as follows:

PLACES OF OBSERVATION.	Difference of level in feet.	Diff. for 1° in feet.	Number of observations
Balloons	1500 to 22897	378	14
Andes and Cordilleras	16404	351	Numerous.
Alps	7822 to 14351	262	6
Teneriffe	12234	412	1
Etna	10620	312	1
Pyrenees	1841 to 10227	305	21
Clermont, France	1247 to 3466	267	7
Williams College	2767	337	28

The rule commonly laid down, is to allow 1° for every 300 feet of ascent; but from the above table, that would seem to be too much, and that 1° to 325 feet would be nearer the truth. It ought, however, to be noticed that all the observations I have quoted were taken, so far as I can learn, in the warmer part of the year. Observations taken in winter might modify the result.

It has been thought that where the slope of the country is gradual, the diminution of temperature from elevation is less than when you compare it on isolated peaks of precipitous mountains with the plains below, or when you ascend in a balloon. Mr. Kirwan estimated that when the rise was not more than six or seven feet per mile, the decrease was not more than 1° in 800 feet; and for any ordinary rise, not more than 1° in 400 feet. By the experiments of Dr. Hutton, near Edinburgh in Scotland, it was 1° in 270 feet; but I do not think his data so satisfactory as those which are furnished by the observations taken at the academies in your State. The latter have been taken for a considerable number of years, according to fixed and uniform rules, and at the same time of day; and though it is possible there may be cases where the observers may not have been as careful

*Since writing the above, I have noticed a series of observations taken at Ithaca (New-York), by Messrs. Cogswell and Eddy, in the year 1837. The distance between the stations was about half a mile, and the difference of level 300 feet. The observations were continued daily through the year, and the result is very remarkable, showing a difference in the mean temperature of 3°.99, which is about 1° to every 75 feet of ascent. There appears to be some mistake in the record, typographical or otherwise, as the annual result does not agree with the average of the semi-monthly results. If the localities are favorable, I hope the experiment will be repeated.

as would be desirable, yet every precaution seems to have been taken by those who had the general direction of them, to secure accurate results. Each observer is required to conform to the rules laid down, and to certify under oath to the accuracy of his observations.

I have attempted to deduce the law from these data; and though some anomalies may be noticed, yet the result on the whole is as satisfactory as could be expected. I have included also a series of observations taken at Williams College, just out of the limits of the State, not more than two or three miles from the line. In prosecuting the investigation, I have compared places two by two having nearly the same latitude but different elevations. In some cases where the latitudes differed too much, I have compared one place with the mean between two or three others. For example, I compared the temperature of Canajoharie, whose latitude is 42° 53′, with the mean of the temperatures of Cazenovia, Bridgwater and Hamilton, whose mean latitude is also 42° 53′. In making the comparison, I have uniformly employed the mean temperature of those years only in which they were reported from both the places compared. The following table shows the result:

LOWER STATION.	UPPER STATION.	Difference of level.	Difference for 1°.	No. of years compared.
Kinderhook	Oxford	836ft.	658ft.	12
Albany	Hartwick	970	334	11
Albany ..... } Lansingburgh }	Williams College*	750	275	12 & 13
Lansingburgh	Cherry-valley	1305	332	13
Canajoharie	Cherry-valley	1051	730	3
Canajoharie	Cazenovia, } Bridgwater, } Hamilton, }	940	663	3, 2 & 3
Utica	Fairfield	712	349	13
Auburn	Pompey	650	154	14
Ithaca†	Oxford	544	206	4
Ithaca, } Aurora }	Homer	664	222	8 & 5
Belleville*	Lowville	550	276	6
Lewiston.............	Rochester	326	265	9

* Elevation estimated. † The year 1837 omitted, on account of a supposed error in the record.

The table shows very clearly that elevation exerts a perceptible influence on the temperature, though with considerable apparent irregularity. Perfect uniformity could not be expected, and perhaps the deviation from a regular law is not greater than would naturally result from the different exposure of the thermometers at the different localities, and other accidental circumstances. In no instance where the difference in the level of two places amounted to 300 feet or more, and where the latitude of both was nearly the same, have I found the mean temperature of the lower station to be less than that of the upper. Utica, as compared with Fairfield, was an exception during the years 1831 to 1837, but not for the whole thirteen years embraced in the table.

On looking over the table, we can hardly fail to notice the slower rate of decrease in temperature as we rise from the valley of the Mohawk, than in other parts of the State; occasioned probably by the greater prevalence of northwest winds in that valley, which tend to reduce its temperature. In the former it averages but 1° in 581 feet; while in the latter, it is 1° in 304 feet. The mean of all the observations compared gives 1° for every 372 feet; but making some allowance for the slow rate in the valley of the Mohawk, I shall assume it at 1° in 350 feet. This result does not differ materially from that which was obtained from observations taken in balloons and on mountain heights, though it would seem from philosophical considerations that there should be a difference.

In regard to the influence of difference of latitude on temperature, we know that the mean annual temperature is greatest near the equator and least toward the poles. If we regard the difference between the equatorial and polar temperatures as the amount due to the sun's influence, Mr. Kirwan found that in mid-ocean this is always nearly proportional to the square of the cosine of the latitude of the place; and in accordance with this law, he calculated a table showing the temperature due to all latitudes. In latitudes varying from 30° to 50°, he makes the temperature diminish about $\frac{9}{10}$ of a degree for each degree of latitude. This, it must be recollected, is intended as the rule on the ocean, remote from either continent. Observations show that such an allowance is too small in Europe, and much more so in this country, where a given change of latitude affects the climate more than it does there.

To find the law in this country, particularly in our own latitude, I compared the temperature of places along the Hudson river, together with Cambridge and Plattsburgh. I selected these places, because, with the exception of difference of latitude, the general circumstances which affect the climate are very similar in them all. They all lie in valleys extending in a north and south direction; are all nearly on the same level, except Cambridge; and the character of the winds is very similar in them all.* The observations at all these places were taken between the years 1826 and 1842, but not all during the same years. It was therefore necessary, in order to compare them properly, to seek for some place where they had been taken during the whole period without interruption, that I might know whether the mean temperature of the years observed at any particular place was higher or lower than the general average. I selected the observations at Albany as such a standard of reference. Its central position in regard to the other places, as well as the care with which the observations there are known to have been taken, seemed a valid reason for doing so.

I next proceeded to compare the mean temperature of each of the places selected, with that of Albany during the same years, and the latter with its mean temperature for the whole seventeen years, varying that of the place compared by the same amount. I then reduced the temperature of all to the level of the sea, by allowing 1° for every 350 feet of

* See article on the winds of the State, published in the Regents' Report for 1840.

elevation. With two exceptions, the reduced temperatures decreased, though not uniformly, as you go north from New-York. The exceptions were, that Newburgh showed a lower temperature than Poughkeepsie, and Kinderhook than Albany.

The mean latitude of the places compared was 42° 13′; the mean temperature reduced to the standard of Albany, and to the level of the sea, 48°.95; and the mean difference for 1° of latitude, 1°.6. Applying Kirwan's formula* to these data, we obtain results which correspond very nearly with the observed temperature, after making a proper allowance for elevation; as appears from the following table. The sixth column was computed as follows: Adding and subtracting ½° to and from the mean latitude, and also adding and subtracting half of 1°.6 to and from the mean temperature, we obtain 49°.75 for the temperature in lat. 41° 43′, and 48°.15 for the temperature in lat. 42° 43′. Let $p =$ the polar temperature of the earth, and $d =$ the difference between the equatorial and polar temperatures;† then by Kirwan's formula,

$$p + (\cos^2 41^\circ 43')\, d = 49^\circ.75,$$

$$\text{and} \quad p + (\cos^2 42^\circ 43')\, d = 48^\circ.15.$$

Reducing these equations, we get $p = -1^\circ.78$, and $d = 92^\circ.49$.

Now let φ be the latitude of any place, and t its temperature; then,

$$t = -1^\circ.78 + 92^\circ.49 \times \cos^2 \varphi.$$

To verify the law, I have applied it to a number of other places beyond the limits of the State under examination, allowing also for the elevation of the place above tide water at the rate of 1° for 350 feet; and the results are seen in the table below.

It would seem that the formula would be more correct, if in place of the square of the cosine of the latitude we should substitute the square of the sine of the sun's meridian altitude; for, 1st, the number of rays of the sun that fall upon any place at noon, is proportional to the sine of the altitude; and 2dly, the intensity of those rays is also nearly proportional to the same.‡ Hence from both united, the heating power must be nearly proportional to the square of the sine of the meridional altitude. In the temperate zones it would evidently make no difference which we use, as the complement of the latitude and the sun's mean meridian altitude are the same; but in the torrid and frigid zones,

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* Dr. Brewster's formula is,

$$\text{Mean temperature} = 86^\circ.3 \times \sin D - 3\tfrac{1}{2}^\circ,$$

in which D represents the distance of the place from the nearest isothermal pole; but the results obtained by it do not correspond so well with those obtained by observation in the State of New-York, as those which we shall deduce from Kirwan's.

† By the terms *equatorial* and *polar* temperatures we are to understand not the temperature actually existing there, but that which would exist if the sun were constantly over the equator.

‡ See Abstract of Prof. Forbes's Report on Meteorology, at the Meeting of the British Society for the Advancement of Science (Am. Journal, Vol. 40, page 319).

the difference would be material. At the equator, the mean meridian altitude of the sun, instead of being 90°, is but 76° 20′; and at the pole, instead of being 0°, it is to be considered 13° 40′, since aside from refraction the sun exerts no heating power when below the horizon. In calculating the temperatures of Havana, Cumana and Quito, which lie in the torrid zone, I corrected the formula as here suggested.

PLACE OF OBSERVATION.	LATITUDE.	ELEVATION.	Mean temp'ture as observed.	Ditto reduced to the standard of Albany, & to the level of the sea.	Calculated temperature.	No. of years observed
Nain, Labrador	57° 08′	30ft.	26° 42	‡26° 51	25° 46	
Quebec, Canada	46 47	340	37.19	38.45	41.50	8
Plattsburgh, New-York,	44 42	105	43.97	44.73	44.95	2
Cambridge, do ..	43 01	†600	45.39	47.22	47.67	14
Lansingburgh, do ..	42 47	30	48.17	48.23	48.05	16
Williams College, Mass.	42 43	800	45.59	‡47.88	48.16	23
Albany, New-York ...	42 39	130	48.27	48.64	48.26	17
Salem, Massachusetts .	42 31	50	48.68	‡48.82	48.47	33
Kinderhook, New-York,	42 22	125	46.91	47.73	48.71	13
Hudson, do ..	42 15	150	48.29	48.75	48.90	10
Redhook, do ..	42 02	†50	48.36	48.95	49.27	12
Kingston, do ..	41 55	188	49.46	50.97	49.44	14
Poughkeepsie, do ..	41 41	†50	51.65	50.88	49.81	11
Newburgh, do ..	41 30	150	48.96	49.59	50.10	13
Newport, Rhode-Island,	41 30	30	50.55	‡50.64	50.10	10
Mount-Pleasant, N. Y.	41 09	125	49 33	50.44	50.66	11
Flatbush, Long island .	40 37	40	51.25	51.39	51.53	17
Philadelphia, Pa.	39 56	30	53.42	‡53.51	53.01	
Cincinnati, Ohio	39 06	510	53.78	‡55.24	53.92	8
Washington, D. C. ...	38 53	30	56.57	56.66	54.26	
Natchez, Mississippi ..	31 28	180	64.76	‡65.27	65.50	8
Havana, Cuba	23 10	30	78.08	‡78.17	76.39	8
Cumana, S. America ..	10 27	30	81.86	‡81.95	83.87	8
Quito, do ..	0 13	9510	62.00	*‡83.75	85.48	

* Reduced by Humboldt's observations

† Height estimated. When a place is said to be at the level of tide water, I have assumed the height of the instrument to be 50 feet.

‡ Mean temperature as observed, reduced to the level of the sea.

NOTE. The observed temperature of Nain, Cincinnati, Philadelphia, Natchez and Havana, was taken from a table in the Bridgwater Treatises; that of Washington and Newport, from the meteorological register of the United States Army; that of Quito, from Rees's Encyclopædia; and that of places in New-York State, from the Regents' Report

After these preliminary investigations, I proceeded to examine the climate of the State, in reference to the mean temperature, the extremes of heat and cold, the length and forwardness of the seasons, and the progress of vegetation.

In estimating the mean temperature of the several localities where observations had been taken, I took it as given in the Regents' Reports for all places where the period of observation amounted to ten years or more. For all others, I compared the mean temperature on the years observed, with the mean for the State on the same years, and the latter with its mean temperature for the whole seventeen years since the observations under the instructions of the Regents were commenced. The mean of the observed temperatures of all the places thus corrected (with the exception of Johnstown, Montgomery, Onondaga, and Millville, whose elevation above tide water I could find no means of estimating) is less than is due to their latitude and elevation, as computed by the foregoing laws, by 0°.16. The coincidence is surprisingly close, and this small difference may be accounted for by the low temperature of several places that enter into the computation, depending upon accidental circumstances, or by error in the assumed elevation of some of the places; or, which is not improbable, by small errors in the data from which the laws were deduced.*

To indicate the forwardness of the seasons, I selected the following facts from a great number of others published in the Regents' Reports, viz. the first appearance of robins in the spring; the blooming of various trees and plants; the ripening of strawberries; the commencement of hay and wheat harvest; and the first killing frost of autumn. The mean time of these for the whole State for fifteen years† ending with 1842, and also the mean temperature and mean annual extremes, is shown in the following table, which may serve as a standard of reference in examining the same kind of facts in the different sections of the State. In preparing this table, I noticed a few obvious errors in the records, which I rejected.

	MEAN DATE.	Number of localities.	Number of observations
Robins first seen	March 19	44	266
Shadbush in bloom ...	May 1	48	168
Peach do ...	" 2*	57	175
Currants do ...	" 4	58	269
Plum do ...	" 6	52	264
Cherry do ...	" 7	52	250
Apple do ...	" 15	59	374
Lilac do ...	" 15	45	151
Strawberries ripe	June 12	58	210
Hay harvest commenced,	July 8	34	127
Wheat harvest ditto ...	" 25	45	186
First killing frost	Sept. 23	57	471
First fall of snow	Nov. 5	....	536
Mean temperature	46°.49	59	577
Mean annual maximum,	92°.00	59	550
Mean annual minimum,	12°.00	59	551
Mean annual range	104°.00	59	550

* As the Peach does not grow in the northern part of the State, this date must be considered as the mean for the southern and middle parts only, and is hence too early as compared with other trees.

*If, the law in respect to latitude remaining unchanged, we should allow 1° of temperature for every 313 feet of elevation, instead of 350 feet as I have assumed, the mean, calculated and observed temperatures would be precisely alike.

† The observations extend through a period of seventeen years, but I was unable to obtain the reports for 1826 and 1827.

In examining the climate of the different sections of the State, I have arranged it for convenience in six divisions, as follows:

1. Long Island;
2. The valley of the Hudson;
3. The valley of the Mohawk;
4. The region north and northwest of the valley of the Mohawk, extending from the east line of the State to Lake Ontario and the St. Lawrence;
5. The region southwest of the valley of the Mohawk, extending from the valley of the Hudson to the vicinity of the smaller lakes;
6. All that part of the State that lies west of the preceding divisions.

EXPLANATION OF THE TABLES.

In each division, I have arranged the facts selected to indicate the character of the climate in three tables. The first is intended to show how the mean temperature of those places where observations have been taken compares with that which is due to their latitude and elevation, that we may see how much it is affected by other causes.

In the second table, the mean temperature and annual extremes of heat and cold at each place are compared with the average of the State during the same years. The sign + denotes that the temperature of the place is higher, or the range of the thermometer greater than the average of the State, by the number of degrees to which it is prefixed; and the sign —, the reverse. I have adopted this course, rather than to give the *actual* mean and extreme temperatures, because I thought it would render the comparison more striking; since now the signs + and — show by a mere glance of the eye, without any labor of computation, whether the temperature is higher or lower than the average of the State. If, however, the actual temperatures are required, they can easily be found by applying the numbers in this table to those in the standard table which I have mentioned above, according to their signs. Thus, if the minimum temperature of a place is marked + 2° in this table, it shows that it is higher by 2° than the average of the State; and the latter is found, by referring to the standard table, to be — 12°. Hence the minimum temperature at the place in question is — 10°.

Table III. shows the forwardness of the seasons at each place, as compared with the average of the State during the same years. The sign + denotes that the time is later than the average of the State, by the number of days to which it is prefixed; and the sign —, that it is earlier. The *actual* time may be found, as in the second table, by applying the number of days given in this table to the dates in the standard table.

I LONG ISLAND.

LOCALITIES OBSERVED. Easthampton, Oysterbay, Jamaica and Flatbush.

TABLE I. *Comparison between calculated and observed temperatures.*

LOCALITIES.	Number of years observed.	LATITUDE.	ELEVATION.	Temperature due to latitude and elevation	Observed temperature.	Variation of observed from calculated temperature
Easthampton	16	41° 00'	16ft.	50°.95	48°.40	—2°.55
Oysterbay	2	40 50	50†	51.03	51.03	— 0.00
Jamaica	17	40 41	100†	51.12	49.43	— 1.69
Flatbush	17	40 37	40	51.39	51.25	— 0.14

† Elevation estimated.

TABLE II. *Comparison of mean temperature, and annual extremes of heat and cold, with the average of the State during the same years.*

FACTS OBSERVED.	Easthampton 15 years.	Oysterbay. 3 years.	Jamaica. 15 years	Flatbush. 15 years.
Mean temperature	+1°.91	+4°.54	+2°.94	+4°.76
Mean annual maximum,	— 2.80	+ 1.66	— 1.20	— 2.80
Mean annual minimum,	+13.87	+15.33	+13.60	+15.67
Mean annual range	—16.67	—13.67	—14.80	—18.47

TABLE III. *Comparison of the forwardness of the seasons, with the average of the State during the same years.*

FACTS OBSERVED.	Easthampton	Oysterbay.	Jamaica.	Flatbush.
	Days	Days.	Days.	Days.
Robins first seen	— 8	......	+ 1*	— 15†
Shadbush in bloom	+ 6	.....	......	— 8†
Peach do	+ 9†	— 8*	— 8†	— 6†
Currants do	+ 5†	......	— 10†	— 12†
Plum do	......	......	— 4	— 9
Cherry do	+ 2	......	— 10†	— 8†
Apple do	+ 9†	......	— 5†	— 5†
Lilac do	......	.....	— 4†	— 6
Strawberries ripe	— 2	......	— 6†	— 12†
Hay harvest commenced,	....	......	— 12	— 9
Wheat harvest ditto ...	— 2†	......	— 12†	— 10†
First killing frost	+ 30†	......	+ 4†	+ 11†

* The result of less than four years' observation.
† The result of observations for ten years or more.

REMARKS ON THE FOREGOING TABLES.

The distinguishing feature in the climate of this section of the State, is the uniformity of its temperature, occasioned by the equalizing influence of the ocean. Although the places of observation are on a low level, and in the extreme south part of the State, the greatest heat of summer is 1½° less on an average, than in other parts of the State which are further north and more elevated. On the contrary, the extreme cold of winter is less by 10° to 18°, and has been so uniformly every year for the past fifteen years.

I am unable to account for the low mean temperature of Easthampton and Jamaica. In the former place it is less than is due to the latitude and elevation by 2°.55, a greater difference than is found at any other place in the State. Nor is this diminished temperature shown by the thermometer only. The backwardness of the spring at the east end of Long Island is still more remarkable. It appears by Table III. that contrary to what we should expect, fruit trees bloom there about a week later than they do in the interior of the State, and a fortnight later than at the west end of the island. This has been very nearly the uniform difference every year for seventeen years past. In fact, the spring is but very little earlier than it is on the Black river in Lewis and Jefferson counties. But notwithstanding the lateness of vegetation in the spring, agriculture does not appear to be so much retarded. Strawberries ripen, and the wheat harvest is commenced there earlier than the average of the State, though considerably later than at the west end of the island. Farther, the time lost by the lateness of the spring appears to be made up in the fall. With scarcely an exception for the past fifteen years, the first killing frost in autumn has occurred much later at Easthampton than at any other place in the State which has been reported. The average time has been a full month later than the average of the State, and nearly three weeks later than at Jamaica or Flatbush.

II. THE VALLEY OF THE HUDSON.

Localities observed. Mount-Pleasant, North-Salem, Goshen, Montgomery, Newburgh, Poughkeepsie, Kingston, Redhook, Hudson, Kinderhook, Albany, Lansingburgh, Cambridge, Salem, Granville.*

TABLE I. *Comparison between calculated and observed temperatures.*

LOCALITIES.	Number of years observed.	Latitude.	Elevation.	Temperature due to latitude and elevation.	Observed temperature.	Variation of observed from calculated temperature
Mount-Pleasant	11	41°09′	125ft.	50°.30	50°.08	— 0°.22
North-Salem	11	41 20	170	49.88	48.01	— 1.87
Goshen	8	41 20	425	49.16	47.59	— 1.57
Montgomery	14	41 32	....	......	47.82	
Newburgh	13	41 30	150	49.67	49.16	— 0.51
Poughkeepsie	11	41 41	50†	49.67	50.74	+ 1.07
Kingston	14	41 55	188	48.90	49.46	+ 0.55
Redhook	12	42 02	50†	49.13	48.81	— 0.32
Hudson	10	42 15	150	48.47	48.32	— 0.15
Kinderhook	13	42 22	125	47.35	46.91	— 0.44
Albany	27	42 39	130	47.89	48.47	+ 0.58
Lansingburgh	16	42 47	30	47.96	48.17	+ 0.21
Cambridge	14	43 01	600†	45.96	45.39	— 0.57
Salem	5	43 15	600†	45.59	45.14	— 0.45
Granville	7	43 20	600†	45.41	46.03	— 0.61

† Elevation estimated. Granville and Salem very uncertain.

* I believe this place does not properly lie in the valley of the Hudson or its tributaries; but I could not conveniently class it elsewhere.

TABLE II. *Comparison of mean temperature, and annual extremes of heat and cold, with the average of the State during the same years.*

FACTS OBSERVED.	Mt Pleasant 11 years.	N. Salem. 11 years.	Goshen. 7 years.	Montgomery. 14 years.	Newburgh. 13 years.	Poughkeepsie 12 years.	Kingston. 14 years.	Redhook. 12 years.
Mean temperature	+3°.59	+1°.52	+1°.10	+1°.33	+2°.67	+4°.25	+2°.97	+1°.92
Mean annual maximum,	+ 0.00	+ 2.72	— 1.57	+ 5.86	+ 1.69	+ 4.24	— 0.14	+ 0.75
Mean annual minimum,	+11.50	— 0.55	+ 1.00	+ 1.00	+ 5.31	+ 2.33	+ 1.43	+ 3.42
Mean annual range....	—11.50	+ 3.27	— 2.57	+ 4.86	— 3.62	+ 1.91	— 1.57	— 2.67

FACTS OBSERVED.	Hudson. 9 years.	Kinderhook. 13 years.	Albany. 15 years.	Lansingburgh 14 years.	Cambridge. 13 years.	Salem. 6 years.	Granville. 7 years.
Mean temperature	+1°.83	+0°.42	+1°.98	+1°.68	—1°.10	—1°.35	—0°.46
Mean annual maximum,	+ 0.96	+ 2.08	+ 0.72	+ 3.14	— 0.05	+ 3.00	+ 2.57
Mean annual minimum,	+ 4.40	— 1.54	+ 0.85	— 4.57	—10.67	—11.83	— 9.14
Mean annual range....	— 3.44	+ 3.62	— 0.13	+ 7.71	+10.62	+14.83	+11.71

TABLE III. *Comparison of the forwardness of the seasons, with the average of the State during the same years.*

FACTS OBSERVED.	Mt. Pleasant.	N. Salem.	Goshen.	Montgomery.	Newburgh.	Poughkeepsie	Kingston.	Redhook.	Hudson.	Kinderhook.	Albany.	Lansingburgh	Cambridge.	Salem.	Granville.
Robins first seen	+11*	— 6	....	— 6	....	— 6	....	— 5*	— 4	— 5†	+ 4	....	+ 0	+ 0*	— 3
Shadbush in bloom	....	— 5	— 7*	— 8*	— 6*	....	....	— 6*	....	— 3	....	....	+ 2	+ 1*	....
Peach do	— 7	— 3	— 1*	— 5	— 8	— 6	— 1	— 3*	— 6	+ 1	+ 9*	— 0*	....	....	....
Currants do	— 9*	— 4	—11*	— 7*	....	— 9	— 7*	....	— 2	— 4	— 2*	— 2	+ 1	+16*	....
Plum do	— 7	— 4	— 2*	— 9	— 5*	—11*	— 5	— 5*	— 6	— 2†	— 2*	— 3†	+ 0	....	....
Cherry do	—12	— 4	— 4*	— 4	—11*	—12*	....	— 7	— 9	— 2	— 5*	— 3	+ 4	....	....
Apple do	—11	— 8†	— 2*	— 5	— 8*	— 6	—10	— 2	— 4	— 2	....	— 5	+ 2†	+ 1*	— 3*
Lilac do	— 0*	— 4	— 4*	....	— 2*	— 7*	—10*	— 1*	— 5	— 1*	....	....	+ 0*	....	....
Strawberries ripe	—13*	— 9†	....	— 0*	....	— 4	— 0*	— 2	— 6	...	+ 1*	+ 4*	+ 1*	+ 4*	....
Haying commenced ...	....	—13†	— 3*	— 3*	....	— 6	+ 3*	— 2*	— 4*	....	....	....	....	....	....
Wheat harvest ditto ...	....	— 6	....	....	....	— 8	....	...	....	....	....	....	....	....	....
First killing frost	+ 9	—10†	...	+ 1	+13	+ 5†	+ 4†	+ 9	+ 6†	+ 0†	+11†	+ 4†	+ 2	....	+ 3

* The result of less than four years observation.

† The result of observations for ten years or more.

REMARKS ON THE FOREGOING TABLES.

There is nothing very peculiar in regard to the mean temperature of this valley as a whole. At North-Salem and Goshen it is considerably lower than is due to the latitude and elevation of those places, and at Poughkeepsie considerably higher. The extreme summer heat is greater by several degrees than in any other section of the State; and this is true not only of the proper valley of the Hudson, but north of it as far as Lake Champlain. There is no other place in the State where the thermometer has risen so high on an average each year as at Montgomery, Poughkeepsie and Lansingburgh. The latter place is not less remarkable for extremes of cold in the winter. For the past fifteen years, without an exception, the thermometer has fallen there lower than the average of the State, generally from 3° to 6° ; and over 5° on an average lower than at Albany. Kinderhook is nearly as remarkable for its extreme cold in winter. These remarks must be understood as applying only to the hottest and coldest days in each year, and not to the average of the seasons. The latter I have not had time to examine.

The climate indicated by the observations at Mount Pleasant in Westchester county, resembles in all respects that on the west end of Long Island, and appears to be subject to the same influences.

North-Salem, like Kinderhook and Lansingburgh, appears to be subject to great extremes of heat and cold, considering its latitude and situation. It is remarkable for its early frosts, which for twelve years past have occurred there ten days sooner than the average of the State, and more than a fortnight sooner than in the valley of the Hudson generally.

As we ascend the Hudson, the opening of spring becomes gradually later, the difference between the vicinity of New-York and Albany being about a week. North-Salem, Goshen and Montgomery being situated at some distance from the river, vegetation seems to be no more forward at those places than at Hudson, which is nearly one hundred miles farther north.

The observations at Cambridge, Salem and Granville, indicate a climate of entirely different character in most respects. From their greater elevation as well as higher latitude, the climate becomes more rigid. The extreme cold of winter is more intense by 10° than at any place on the Hudson south of Lansingburgh, and the spring opens several days later.

III. THE VALLEY OF THE MOHAWK.

Localities observed. Schenectady, Johnstown, Canajoharie, Fairfield, Utica, Whitesborough.

TABLE I. *Comparison between calculated and observed temperatures.*

LOCALITIES.	Number of years observed.	Latitude.	Elevation.	Temperature due to latitude and elevation	Observed temperature.	Variation of observed from calculated temperature.
Schenectady	5	42° 48′	†200ft.	47°.45	46°.48	— 0°.67
Johnstown	11	43 00	....	......	45.19	....
Canajoharie	3	42 53	284	47.08	45.48	— 1.60
Fairfield	13	43 05	1185	44.20	43.51	— 0.69
Utica	17	43 06	473	46.20	45.49	— 0.71
Whitesborough	7	43 08	450	46.21	45.59	— 0.62

† Elevation estimated.

TABLE II. *Comparison of mean temperature, and annual extremes of heat and cold, with the average of the State during the same years.*

FACTS OBSERVED	Schenectady. 6 years.	Johnstown. 12 years.	Canajoharie. 4 years.	Fairfield. 14 years.	Utica. 15 years.	Whitesboro'. 7 years.
Mean temperature	—0°.01	—1°.30	—1°.01	—2°.98	— 1°.00	—0°.98
Mean annual maximum,	— 3.17	+ 0.50	+ 3.00	— 2.21	— 2.43	+ 2.80
Mean annual minimum,	0.00	— 3.25	— 7.50	— 4.14	— 3.50	— 2.60†
Mean annual range	— 3.17	+ 3.75	+10.50	+ 1.93	+ 1.07	+ 5.40

† On the 13th of February, 1837, the thermometer is reported to have fallen to — 32° ; and on the 31st of January, 1838, to — 28° ; but as it did not fall lower than — 16° on those days at any other place on the Mohawk, including Utica, which is but four miles distant, I conclude these to be errors, and have rejected them.

TABLE III. *Comparison of the forwardness of the seasons, with the average of the State during the same years.*

FACTS OBSERVED.	Schenectady.	Johnstown.	Canajoharie.	Fairfield.	Utica and Whitesboro'.
	Days.	Days.	Days.	Days.	Days.
Robins first seen	+10*	+ 1	— 2*	— 4	+ 2*
Shadbush in bloom ...	....	+ 4*	—13*	...	....
Peach do	....	....	+11*	....	....
Currants do	— 3*	+ 4	....	+ 7	0
Plum do	....	+ 2	—13*	+ 6	+ 2†
Cherry do	— 5*	+ 3	— 2	+ 0	— 6
Apple do	— 3*	+ 1	— 4	+ 7	+ 3†
Lilac do	— 2*	....	— 7*	+ 6*	0
Strawberries ripe	— 8*	— 1	— 3	+ 5	0
Hay harvest commenced,	....	....	+ 5*	+ 8	— 4
Wheat harvest ditto ...	....	....	+ 2	...	— 1
First killing frost	....	— 5†	...	—11	— 1†

* The result of less than four years observation. † The result of observations for ten years or more.

REMARKS ON THE FOREGOING TABLES.

The low temperature of the valley of the Mohawk has been already referred to. It is more than 1° lower than the average of the State, and nearly 1° lower than is due to the latitude and elevation of the places of observation, with a tolerable degree of uniformity throughout. The elevation of Johnstown not being known, I could not include it in the comparison between the observed and calculated temperatures; but if I am not greatly deceived, it would, if included, render the difference still greater. I would not be too sanguine in the explanation I gave of the cause of this reduced temperature, but I am inclined to think it is the true one. In an article on the winds of the State already referred to, it is shown that while the mean direction of the wind throughout the State is S. 76° 54′ W., it is several degrees more northerly in the valley of the Mohawk generally. It is not so at Utica; but there is reason to believe that most of the winds that strike that place from the west, should be regarded as northwest winds.* To show the influence of

* See an article on the winds at Utica, in the Regents' Report for 1829, pages 69 and 70.

winds from different points of compass on the temperature, I venture to transcribe the results of some observations made by myself at Ogdensburgh, in the year 1838. I consider that locality a pretty fair one for the experiment.

In the following table, the second column shows the number of days, hours and minutes that the wind blew from each point of compass during the year; and the third, the average rise or fall in the thermometer per hour during each wind, expressed in decimals of a degree. The sign + denotes a rise, and the sign — a fall.

COURSE OF WINDS.	DURATION OF WINDS. d h m	Variation in temperature per hour.
North	7 5 15	— 0.197
N by E	5 22 15	— 0.165
NNE	8 0 15	— 0.144
NE by N	10 15 15	— 0.063
NE	14 1 52	— 0.015
NE by E	16 12 30	+ 0.094
ENE	13 4 38	+ 0.115
E by N	4 21 30	+ 0.077
East	2 15 15	+ 0.103
E by S	2 8 15	+ 0.162
ESE	2 15 45	+ 0.146
SE by E	2 13 15	+ 0.114
SE	2 17 29	+ 0.140
SE by S	4 3 8	+ 0.145
SSE	7 4 14	+ 0.138
S by E	8 7 31	+ 0.161
South	20 4 0	+ 0.314
S by W	21 4 45	+ 0.177
SSW	22 6 45	+ 0.162
SW by S	22 16 30	+ 0.065
SW	29 12 15	— 0.018
SW by W	25 21 30	— 0.055
WSW	16 23 45	— 0.018
W by S	13 6 0	— 0.081
West	17 5 45	— 0.063
W by N	11 14 7	— 0.069
WNW	8 19 8	— 0.252
NW by W	9 8 53	— 0.281
NW	8 20 38	— 0.322
NW by N	9 15 37	— 0.306
NNW	8 2 15	— 0.276
N by W	6 9 46	— 0.236
TOTAL ..	365 0 0	

Now if the effect of the different winds is the same in the valley of the Mohawk as at Ogdensburgh, and if we regard the west winds at Utica and Whitesboro as coming from the northwest, the following statement of the number of observations at which the winds blew from the several points of compass at each place for the past seventeen years, so far as reported, shows that they must reduce the temperature.

	N.	NE.	E.	SE.	S.	SW.	W.	NW.
Schenectady	100	117	85	343	281	96	557	613
Johnstown	53	629	1268	451	107	698	4264	626
Canajoharie	8	1	182	292	40	72	401	464
Fairfield	109	111	1460	1505	255	486	1809	3663
Utica	33	64	2472	1200	735	1075	6359	467
Whitesborough	234	106	1100	296	460	464	1937	517

At Schenectady and Canajoharie, vegetation advances more rapidly than the average of the State, and at Johnstown and Fairfield less so. The difference between Canajoharie and Fairfield, though but twenty miles distant, is about a fortnight, owing chiefly to the high elevation of the latter place. Utica seems to be not only situated near the geographical centre of the State, but to be a pretty fair representative of it in respect to climate. Its mean temperature is but 1° lower than that of the State as a whole; and in regard to the progress of vegetation, it agrees within a day.

IV. THE REGION NORTH AND NORTHWEST OF THE VALLEY OF THE MOHAWK.

Localities of observation. Mexico, Belville, Lowville, Gouverneur, Ogdensburgh, Potsdam, Malone and Plattsburgh.

TABLE I. *Comparison between calculated and observed temperatures.*

LOCALITIES.	Number of years observed.	Latitude.	Elevation.	Temperature due to latitude and elevation	Observed temperature.	Variation of observed from calculated temperature
Mexico	5	43° 27′	330ft.	46°.04	44°.49	— 1°.05
Belville	7	43 45	260†	45.74	45.27	— 0.47
Lowville	14	43 47	800	44.15	44.07	— 0.08
Gouverneur	10	44 25	400	44.27	43.24	— 1.03
Ogdensburgh	1	44 43	225	44.27	44.43	+ 0.16
Potsdam	15	44 40	394	43.84	43.26	— 0.58
Malone	3	44 50	645	42.89	43.40	+ 0.51
Plattsburgh	2	44 22	105	44.65	45.87	+ 1.22

† Elevation estimated.

TABLE II. *Comparison of mean temperature, and annual extremes of heat and cold, with the average of the State during the same years.*

FACTS OBSERVED	Mexico. 4 years.	Belville. 7 years.	Lowville. 12 years.	Gouverneur. 9 years.	Ogdensburgh. 1 year.	Potsdam. 15 years.	Malone. 3 years.	Plattsburgh. 2 years.
Mean temperature	— 2°.00	— 1°.22	— 2°.42	— 3°.25	— 2°.06	— 3°.23	— 3°.09	— 0°.62
Mean annual maximum,	+ 1.55	+ 1.43	+ 3.00	+ 1.45	+ 1.00	— 1.13	— 2.66	— 5.50
Mean annual minimum,	— 3.20	—10.00	—16.00	—17.55	— 1.00	—11.80	— 8.33	— 7.00
Mean annual range	+ 4.75	+11.43	+19.00	+19.00	+ 2.00	+10.67	+ 5.67	+ 1.50

TABLE III. *Comparison of the forwardness of the seasons, with the average of the State during the same years.*

FACTS OBSERVED.	Mexico.	Belville.	Lowville.	Gouverneur.	Potsdam.	Malone.	Plattsburgh.
	Days.	Days.	Days.	Days	Days.	Days.	Days.
Robins first seen	+ 1	+ 0*	+ 8*	— 3	+ 7†	+ 9	+ 9*
Shadbush in bloom ...	+ 7*	+ 6*	....	+ 1*	+ 5†	+11*	....
Currants do	+ 3*	+ 8	+ 6	+11	+ 5	+21*	....
Plum do	+ 3*	+ 4	+ 3†	+ 5	+ 3†	+13*	+12*
Cherry do	+ 6*	+16*	+ 9*	+15*	+10*	....	+12*
Apple do	+ 2*	+ 4	+ 7†	+12*	+ 5†	+12*	+19*
Lilac do	+ 1*	+14*	+ 6	+ 4*	+11	+ 6*	+11*
Strawberries ripe	+12*	+12*	+ 8	+ 6*	+ 0†	+ 9*	+ 7*
Haying commenced ...	+15*	— 2*	...	— 1*	+ 7	+ 6*	+19*
Wheat harvest ditto ...	....	....	....	....	+ 9	....	....
First killing frost	— 3	— 2	—10†	—11†	—16†	....	....

* The result of less than four years observation. † The result of observations for ten years or more.

REMARKS ON THE FOREGOING TABLES.

Here, with the exception of Ogdensburgh and Plattsburgh, we have all the characteristics of a more rigid climate: low mean temperature, extreme cold in winter, great range of the thermometer, backward seasons and early frosts. The temperature is not, however, much lower on the whole than is due to the latitude and elevation of the places of observation. Gouverneur is colder by over 1°, and appears to be the coldest place but one in the State from which reports are received. In regard to extreme cold in winter, it stands unrivalled, and that with almost perfect uniformity every year. The observations at Ogdensburgh were taken but for a single year; but if that is a fair specimen, its temperature is more uniform and less liable to extremes of heat and cold than the average of the State. This may be accounted for by the equalizing influence of the St. Lawrence river, which is a mile and a quarter wide at that place, and scarce ever freezes over in the winter. On the other hand, it maintains a considerably lower temperature than the surrounding air in the summer season. Being composed of so vast a body of water, its temperature is but slowly affected by that of the country through which it passes; and it partakes, in considerable degree, of the uniformity of Lake Ontario in this respect.*

The following statement in regard to the temperature of Lake Ontario, will be of service in enabling us to estimate its influence on the climate of the surrounding country. It is deduced from experiments made under the direction of Prof. Dewey of Rochester, in the years 1837 and 1838, and shows the mean of eight observations, taken every six or eight

* See Observations on the temperature of the St. Lawrence, published in the Regents Report for 1838, page 218.

miles across the lake, from the mouth of Genesee river to Coburg in Canada (not including those made near the shores), and about a foot below the surface.

May 14 & 15	39°.31
" 21 & 22	39.00
June 19	47.50
Aug. 7	66.00
Sept. 4	60.25
Oct. 16	53.12
Nov. 13	45.75

Prof. Dewey accounts for the low temperature in May, by the melting of the ice on Lake Erie.

V. THE REGION SOUTH AND SOUTHWEST OF THE VALLEY OF THE MOHAWK.

LOCALITIES OF OBSERVATION. Pompey, Homer, Cazenovia, Hamilton, Bridgwater, Oxford, Hartwick, Cherry-valley, Delhi.

TABLE I. *Comparison between calculated and observed temperatures.*

LOCALITIES.	Number of years observed.	LATITUDE.	ELEVATION.	Temperature due to latitude and elevation.	Observed temperature.	Variation of observed from calculated temperature.
Pompey	16	42° 56′	1300ft.	44°.09	42°.91	— 1°.18
Homer	10	42 38	1096	45.16	44.17	— 0.99
Cazenovia	14	42 55	1260	44.23	43.58	— 0.65
Hamilton	11	42 49	1127	44.77	44.32	— 0.45
Bridgwater	4	42 55	1286	44.15	43.82	— 0.33
Oxford	13	42 28	961	45.82	44.91	— 0.91
Hartwick	11	42 38	1100	45.15	45.46	+ 0.31
Cherry-valley	13	42 48	1335	44.20	44.18	— 0.02
Delhi	3	42 16	1384	44.92	44.59	— 0.33

TABLE II. *Comparison of mean temperature, and annual extremes of heat and cold, with the average of the State during the same years.*

FACTS OBSERVED.	Pompey. 14 years.	Homer 11 years.	Cazenovia. 12 years	Hamilton. 10 years	Bridgwater 4 years.	Oxford. 15 years.	Hartwick 9 years	Cherryvalley 12 years	Delhi. 4 years.
Mean temperature	— 3°.52	— 2°.32	— 2°.91	— 2°.17	— 2°.67	— 1°.58	— 1°.03	— 2°.31	— 1°.90
Mean annual maximum,	— 4.43	— 1.36	— 1.42	+ 0.70	— 0.00	— 0.14	— 2.38	— 2.08	— 0.00
Mean annual minimum,	+ 0.93	— 4.91	— 7.00	— 10.60	— 7.75	— 10.67	— 5.88*	— 7.25	— 6.50
Mean annual range	— 5.36	+ 3.55	+ 5.58	+ 11.30	+ 7.75	+ 10.53	+ 3.50	+ 5.17	+ 6.50

* The observation for 1835 rejected, on account of supposed errors.

TABLE III. *Comparison of the forwardness of the seasons, with the average of the State during the same years.*

FACTS OBSERVED.	Pompey.	Homer.	Cazenovia.	Hamilton.	Bridgwater	Oxford.	Hartwick.	Cherryvalley	Delhi.
	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.	Days.
Robins first seen	+ 0	....	— 5†	— 9†	+12*	—10	....	....	....
Shadbush in bloom	....	+ 7	....	+ 5	+ 3*	+ 1	....	....	+ 3
Peach do	....	+10*	....	....	....	....	....	....	....
Currants do	+ 2†	+ 2	+ 4†	+ 5†	+ 9*	+ 1†	+ 3	+ 7*	+ 3*
Plum do	+ 6	+ 1†	+ 6	+ 2	+ 3*	+ 1†	+ 2	+ 7	+ 3*
Cherry do	+ 3	+ 2†	+ 7	+ 1	+15*	+ 5*	+ 4	+10*	+ 1*
Apple do	+ 9†	+ 3†	+ 8†	+ 4†	+ 6*	+ 3†	....	+ 8	+ 5
Lilac do	+ 9	+ 6	+ 3	+ 2	+ 9*	+ 3	+ 6*	+ 8*	....
Strawberries ripe	+ 5	+ 2†	+ 7	+ 4	+ 6*	+ 2	+ 2*	+ 2	+ 6*
Haying commenced ...	+ 3	+ 3†	+ 7†	— 1	+ 7	....	+13*	....	....
Wheat harvest ditto ...	....	+ 3†	+ 9	....	....	....	....	...	....
First killing frost	+ 1†	—13†	—11†	—12†	....	— 6†	— 9	— 4†	....

* The result of less than four years' observation. † The result of observations for ten years or more.

REMARKS ON THE FOREGOING TABLES.

Most of these places lie in elevated valleys, and show a proportionably reduced temperature as compared with others in the same latitude but on a lower level. Pompey is the coldest place reported in the State; colder even than those in the extreme northern counties. It is situated on high ground, but still the temperature is lower than is due to its elevation by over 1°. But it is rather remarkable that while this is the fact, the thermometer does not sink so low there in the winter, nor do autumnal frosts occur so early as in the State generally. At all the other places in this section the thermometer sinks lower than the average of the State by 4° to 11°, and autumnal frosts occur earlier by four to thirteen days.

The appearance of robins seems not to be a fair index of the relative forwardness of the spring at different places, as they appear earlier in this section than at any other in the State; and yet vegetation is uniformly backward, though not so much so as at places in the northern part of the State which have the same mean temperature.

VI. THE WESTERN PART OF THE STATE.

LOCALITIES OF OBSERVATION. Onondaga, Auburn, Aurora, Ithaca, Prattsburgh, Canandaigua, Palmyra, Rochester, Henrietta, Middlebury, Gaines, Millville, Lewiston, Buffalo, Springville, Fredonia, Mayville.

TABLE I. *Comparison between calculated and observed temperatures.*

LOCALITIES.	Number of years observed.	LATITUDE.	ELEVATION.	Temperature due to latitude and elevation.	Observed temperature	Variation of observed from calculated temperature.
Onondaga	14	42° 59′	....	.....	47°.54	....
Auburn	15	42 55	650ft.	45°.97	46.86	+ 0°.89
Aurora	8	42 43	447	46.90	48.07	+ 1.17
Ithaca	11	42 27	417	47.39	47.88	+ 0.49
Prattsburgh	6	.. 34	1494	44.12	44.67	+ 0.55
Canandaigua.........	12	42 50	510†	46.42	46.01	— 0.41
Palmyra	1	43 05	450	46.39	46.55	+ 0.16
Rochester	11	43 08	506	45.65	46.50	+ 0.85
Henrietta	3	43 06	600	45.83	47.21	+ 1.38
Middlebury	14	42 49	800	45.71	46.79	+ 1.08
Gaines	4	43 17	422	46.22	46.62	+ 0.40
Millville	3	43 08	....	.....	44.97	....
Lewiston	11	43 09	280	46.27	47.92	+ 1.65
Buffalo	2	42 50	605	46.23	45.65	— 0.58
Springville...........	3	42 30	1105	45.34	47.34	+ 2.00
Fredonia	12	42 26	645	46.75	47.79	+ 1.04

† Elevation estimated.

TABLE II. *Comparison of mean temperature, and annual extremes of heat and cold, with the average of the State during the same years.*

FACTS OBSERVED.	Onondaga. 12 years	Auburn. 15 years.	Aurora 8 years.	Ithaca 12 years.	Prattsburg 7 years.	Canandaigua 12 years.	Palmyra. 2 years.	Rochester. 11 years.
Mean temperature	+ 1°.05	+ 0°.37	+ 1°.58	+ 1°.39	— 1°.82	— 0°.48	+ 0°.06	+ 0°.01
Mean annual maximum,	+ 0.25	— 4.00	— 1.83	+ 1.50	+ 1.29	— 1.58	+ 2.50	— 0.10
Mean annual minimum,	— 0.17	+ 5.53	+ 7.67	+ 4.08	— 2.57	+ 7.42	+11.00	+10.45
Mean annual range....	+ 0.42	—10.13	— 9.50	— 2.58	+ 3.86	— 9.00	— 8.50	—10.55

FACTS OBSERVED.	Henrietta. 3 years.	Middlebury 12 years.	Gaines. 4 years	Millville 3 years.	Lewiston. 11 years.	Buffalo 1 year.	Springville 4 years	Fredonia. 12 years
Mean temperature	+ 0°.72	+ 0°.30	+ 0°.13	— 1°.52	+ 1°.43	— 0°.84	+ 0°.85	+ 1° 30
Mean annual maximum,	+ 1.00	+ 1.33	— 0.50	— 0.66	— 0.82	— 0.00	— 0.25	— 0.50
Mean annual minimum,	+12.33	+ 2.58	+ 9.50	+ 5.33	+11.73	+ 2.50	+ 3.50	+ 9 33
Mean annual range....	—11.33	— 1.25	—10.00	— 4.07	—12.55	+ 8.00	— 3.75	— 9.83

TABLE III. *Comparison of the forwardness of the seasons, with the average of the State during the same years.*

FACTS OBSERVED.	Onondaga.	Auburn.	Aurora.	Ithaca.	Prattsburgh.	Canandaigua.	Palmyra.	Rochester.	Henrietta.	Middlebury.	Gaines and Millville.	Mayville.	Lewiston.	Buffalo.	Springville.	Fredonia.
	days	days.	d ys	days	days	days	days	days	days.	days	days	days	days	days	days.	days.
Robins first seen	—0	+ 1	....	+10*	+ 0	—0	+15*	—2	....	....	+1	...	+1†	+11†	...	—2
Shadbush in bloom	+5	— 5	+ 3*	+ 6	....	—4	— 3*	+1	—10*	—1	+1	....	...	....	....	—5*
Peach do	+4	+ 2	— 0*	— 1	+10*	+2†	— 1*	—1	— 5*	....	+5	+9*	+1	+ 9*	+5*	—2†
Currants do	—3†	— 1	— 4*	— 4*	+ 6*	—0	— 0*	—0*	— 3*	—0*	+2*	+4*	—4*	....	+6*	—6
Plum do	—1†	...	— 4*	— 5	+ 5	—2*	— 2*	—5*	— 3*	—3	+1	+4*	+2*	....	—3	—8
Cherry do	—2	— 9*	—10*	— 9	+ 3	—4*	...	—0*	— 7*	....	+5	+3*	—0	....	+6*	—8
Apple do	—0†	— 4	— 7*	— 6	+ 1	—0	+ 3*	—3*	— 1*	—0†	+0	+0*	—0	....	—1	—2†
Lilac do	—0*	— 4*	— 5*	— 7*	+ 7	+2*	....	—2*	— 4*	....	+2*	....	—3	+ 8*	...	—5
Strawberries ripe	—0	+10*	+ 3*	— 0*	+ 6*	....	....	—2*	....	....	+1	....	—4	+ 5*	....	—6
Haying commenced ...	—1†	+ 2*	...	— 0*	+ 9*	—0	— 3*	—3*	....	....	+6*	....	....	....	....	+2*
Wheat harvest ditto ...	—3†	....	....	....	....	....	....	....	....	+6	....	....	....	....	....	....
First killing frost	+6†	+ 1†	+12	— 5†	— 3	+3†	....	+9	....	—3†	....	....	—5†	....	....	+1*

* The result of less than four years observation. † The result of observations for ten years or more.

REMARKS ON THE FOREGOING TABLES.

I thought of subdividing this section into three, viz. the vicinity of the smaller lakes, the Genesee valley, and the western counties; but there is such a similarity of climate throughout the entire region, so far as is shown by the reports, that I concluded to embrace the whole in one division.

Its mean temperature does not differ much from the average of the State, but is remarkably uniform; more so than in any other section, except Long island. With the exception of Prattsburgh which is situated on high ground, Buffalo where observations were taken but for a single year, and Onondaga which seems to be hardly far enough west to show the characteristic climate of this section, but partakes more of that which reigns farther east, the average annual range of the thermometer is but 96°; while in the State generally it is 104°, and in the northern counties nearly 120°. The greatest cold in winter at Rochester, Lewiston or Fredonia, but little exceeds that which is found on Long island or at New-York. Vegetation in the spring is a few days earlier than the average of the State; about the same as at Albany.

But the most interesting fact developed by the observations in this section, is the change in the circumstances that affect the temperature (other than latitude and elevation) as we pass from the east into the basin of the smaller lakes, and so on westward. East of this section, twenty-seven places out of thirty-two showed a lower mean temperature than was due to their latitude and elevation; here, all but two a higher. Whether this is to be ascribed to the geological character of the country, or to the more southerly direction of the winds, or to both, or to some other cause, I would not venture to decide. The winds in this section are, on an average, about 11° more southerly than the mean for the State, as appears from the following statement, which I copy from the article on the winds of the State, already referred to.

Onondaga	S 67° 8′ W
Auburn	S 74° 55′ W
Aurora	S 52° 40′ W
Ithaca	S 62° 47′ W
Prattsburgh	S 76° 46′ W
Canandaigua	S 62° 50′ W
Palmyra	S 69° 7′ W
Rochester	N 89° 32′ W
Henrietta	S 44° 19′ W
Middlebury	S 72° 31′ W
Lewiston	S 45° 58′ W
Buffalo	S 42° 40′ W
Springville	N 81° 4′ W
Fredonia	S 64° 42′ W
Average	S 66° 6′ W
Mean for the State	S 76° 54′ W
Difference	10° 48′

The want of observations in the southern part of this section renders it impossible to say how far the peculiarity in the climate we are speaking of extends in that direction. We notice it as far south as Prattsburgh, which is within forty miles of the south line of the State, and nearly fifteen hundred feet above the level of the sea.

There is great uniformity in the extreme heat of summer throughout the State. But five places out of fifty-five show a difference of over 3° from the mean of the State, which is 92°.

The average time for the whole State, from the blooming of apple trees to the first killing frost in autumn, deduced from over nine hundred observations, is one hundred and seventy-four days. On the west end of Long island it is twelve and a half days more, and in St. Lawrence country twenty-two less; the difference between the two latter being consequently thirty-four and a half days.

I intended to have added some remarks on the stability of the climate of the State, and several other matters, but am compelled from want of time to omit them.

JAMES H. COFFIN.

View of the Adirondack Pass.

CHAPTER IV.

AGRICULTURAL GEOLOGY.

GENERAL OBSERVATIONS ON THE SOILS DERIVED FROM THE DECOMPOSITION OF DIFFERENT ROCKS. CLASSIFICATION OF ROCKS. ANALYSIS OF SIMPLE MINERALS: FELSPAR AND ALBITE; LABRADORITE; HORNBLENDE; HYPERSTHENE; SERPENTINE; BASALT AND GREENSTONE. DRIFTED SOILS.

§ 1. Soils derived from the decomposition of different rocks.

In the pursuit of an important object, it is wise and proper to avail ourselves of all the aids within our reach to secure its attainment; and it is an imperious duty so to do, when the object to be attained is surrounded with difficulties, and where every ray of light is wanted to illuminate dark and obscure points. Upon agriculture all the modern sciences send their lights, some more and some less; all, however, impart something, and lend their aid to its promotion. In this office geology is behind none other, unless it be chemistry, whose range is not only great, but minute, affecting every and all departments. A great many facts strictly geological have an important bearing upon the subject before us; such as the nature of the rock, its structure and position, its composition, its relations to moisture, and liability to solution. The position of the rocks of a district, as has been already remarked in the first chapter, is always an important point, and in some cases all that is essentially requisite; for they often add value to their possession, even when they can not be turned to account directly in the cultivation of the soil.

Under the influence of these considerations, and others of minor importance which it is unnecessary to state, I propose to give first of all a recapitulation of the geology of New-York, with a view of applying all the facts which bear upon agriculture to its illustration. For the convenience of description, I shall pursue the plan adopted in the geological reports, namely, that of describing the rocks in the ascending order; and this will lead me to speak of them in the order of the districts which I have already briefly described, and into which the State has been divided.

The six districts coinciding nearly with six groups of rocks, each of these groups respectively impart to the overlying soil some of its distinguishing characters, or in a good measure make it what it is. Modifying influences, however, independent of the geological formation, have done something as diluvial or transporting agents, by which soils originating and formed at a distance have been brought to and distributed over adjacent districts. Still it will be found on examination that the underlying rocks have given a stronger character to the soft materials than has usually been supposed, leaving out of view some areas in every district where drift has lodged in deep beds.

In estimating the amount of soil furnished by groups of rocks, we are necessarily obliged to observe the nature of the masses. Many of the shales and slates, and they occur in almost every group, disintegrate rapidly, the action being favored both by water and frost: the first, penetrating between the laminæ, partially separates them; and in some instances no other agent is required to effect an entire destruction of a stratum, especially where wetting and drying alternately occur. In other cases, the assistance of frost is required to effect a complete reduction of the strata to soil.

Limestones are liable to a constant loss of material by solvent properties of rain-water, which holds carbonic acid in solution; and this operation is favored by a rough or uneven surface, where the water stands for a time. On a polished surface, the action of water and other agents is very slow and inconsiderable even after the lapse of several years, as is proved by the durability of the marbles used in the construction of monuments, and by that of other rocks when carefully smoothed; whereas upon the exposed surfaces of quarries, the sloping sides are often deeply grooved by the water which slowly trickles over their surfaces.

Granite and gneiss disintegrate and decompose from their peculiar chemical composition, and the presence of alkalies in the felspar and mica exert a powerful influence in these changes. High granitic peaks in the region of frosts undergo a rapid decay, and in consequence furnish upon the slopes and in the valleys beneath their peculiar soils, which are well adapted to grass and grain. The alkalies in these rocks, if completely insulated, would pass off rapidly through the soft materials, and be lost to vegetation. They are, however, so combined with silica, that they are comparatively unaffected by the common solvent, water, and hence are retained in the soil for the use of plants.

Other kinds of rocks liable to decay, are the siliceous limestones, one of which is the calciferous sandstone. It appears from examination that the lime is dissolved out, leaving upon the surface the silex in grains, which falls off by its own weight, or else is rubbed off by friction. The dissolved lime, however, does not all pass into and remain in the soil, but is carried down, and forms very frequently with other materials a *hardpan*, a puddingstone, or concretions, the lime acting as a cement; in other instances it percolates into and through the rock, and forms stalactites, veins or other deposites. The same action or power which dissolves the carbonate of lime in solid rocks, dissolves also that which may be diffused through the soil. This takes place where the surface is frequently stirred, as in cultivated fields. Thus this element is removed both by vegetation and by the ordinary action of rain-water, and hence its deficiency in most of the soils of New-York and New-England.

§ 2. Classification of rocks.

The classification of rocks has been a most perplexing study to geologists. They have not disagreed, however, so much as to the planes where lines of separation should be drawn, as in the designation of the masses. The ancient names, *primitive*, *transition* and *secondary*, have all been objected to, and have been abandoned by many of the European writers. In consequence of this, others have been proposed as substitutes, and have been adopted in part; but the proposed names are about as objectionable as the old ones, and hence much hesitancy has been manifested in their adoption. Without attempting to decide which nomenclature is best, I shall use that which the public is most familiar with.

The word *primary* is a term whose meaning is well fixed in this country, being applied to those masses which were consolidated before the creation of organic bodies. This term then will be used to designate a class whose existence was anterior to that of organic beings. It is true that some masses belonging to this class have been in a liquid or fused state since the existence of organic bodies; still, so far as observation extends, the great mass or crust of the earth is made up of granite, gneiss, mica slate, hornblende, serpentine and primary limestone; and doubtless these masses were consolidated anterior to the period spoken of.

The word *sedimentary* is another term, the meaning of which cannot be misunderstood or misapplied. It will be used to designate those masses which are really consolidated sediments. It will often be used as synonimous with the word *stratified*, inasmuch as all sediments are disposed to arrange themselves in layers or strata. The materials in this case lie in parallel beds, varying greatly in thickness; all, however, separable from each other through the planes of deposition, each of which may be distinguished by lines upon the faces of a ledge, by some diversity in the materials, or difference in the colors of two adjacent beds. Other lines, however, appear both upon the ends or surfaces of beds, which are not indicative of bedding planes. Thus, when we find regular forms as rhomboids marked upon rocks, they are not to be taken at all as the result of deposition. No difference of materials or difference of color can be discerned along these lines. Such regular forms are therefore the effects of crystallization. In some masses, however, both kinds of planes may be found. If the beds are horizontal, the upper and lower planes are those of deposition; but they may lie in any other direction, as the vertical, or oblique in various degrees. The other lines course along upon the planes of deposition, and produce rhomboids or other mathematical forms. In other cases, again, *all* the planes are the effects of crystallization. Those which appear in granite, in trap, serpentine and primary limestone, are never planes of deposition. The forms which these rocks give us are more obtuse than those in slates and shales; they are frequently nearly square blocks. All these planes serve an important purpose; and though they are really produced by the operation of a constant law in the inorganic world, yet they bear the impress of design: they facilitate the dissolution of the mass, and by that means assist in preserving a due balance in matters above and below water; they are highly important as a means of separating and raising the layers from their beds, and thus aid in quarrying. Without them, it would be impossible to raise stones for flagging, and for a variety of other useful purposes.

The first great division of rocks, then, is into *Primary* and *Sedimentary*. The former are divided into two kinds: those which are *massive*, or destitute of planes analogous to planes of deposition, as granite; and those which are *stratified*, as gneiss, mica slate, etc.

It is proper, however, to observe in this place, that all rocks divide by different kinds of planes. Those which are not the planes of deposition, are termed *joints;* and hence a rock is said to be jointed, when planes exist in a direction different from that of the planes of deposition.

Sedimentary rocks are subdivided into several systems. By the term *system*, is meant a series of rocks formed and deposited in the course of a single period or era, during which nearly the same orders of organic beings existed; each system being marked, both at its coming in and going out, by some great change in the condition of things. The outgoing and the incoming of a system is indicated by changes in the sediments, in their position, and in the character of the organic beings of the time and place. It will be conceived, then, that the lines of demarkation between systems are the most important of all. The most instructive study is that of the diversity of these systems; as from it we learn the history of the earth, its revolutions and changes. We are not, however, to receive all the doctrines which are advanced in relation to changes and revolutions as fully proved. At the time when organic beings first existed, certain essentials in organization were necessary.

A physical system was then established, and to this system organic beings were to be adapted. There were controlling agents. Of these the atmosphere was one, and caloric another; and these have continued and will continue to control the types of organization to the end of time. Vary the present standard, if only in a narrow compass, and but few if any of the present races would continue to exist.

In view of this subject, I hazard the assertion that the composition of the atmosphere was never essentially different since the *Nereites* of the Taconic system were created; and also that the temperature has never been greater than it is now, since that period. This is going back as far as it is possible with organic beings: none older are now known to exist. Because a lizard or crocodile does not consume so much oxygen as an ox in a given period, it does not follow that in the era of the Lias, an era of lizards, the atmosphere contained less oxygen or more carbonic acid than it does now; for with their respiratory apparatus, we have a right to infer that if the proportion of oxygen was less than it is at present, they would not be supplied with that material, and enough could not be obtained if less existed in the atmosphere. When we speak, therefore, of the changes which usher in a new system, it is not intended to inculcate the doctrine that they were so great, or of such a character, as would be incompatible with the present; or that organic beings would be unfitted organically for any other period or era in the world's history.

Systems are subdivided into groups; the groups holding the same relation to a system, as the system to the totality of the consolidated sediments. The beginning and end of a group is marked by some important change, such as the disappearance of affiliated tribes and species. It is then by observations of this kind, that divisions and subdivisions of the sediments are obtained. Names which are supposed to be appropriate at the time, are conferred upon the systems and groups. They may subsequently, however, be demonstrated to be inappropriate; the progress of discovery outgrowing and thereby rendering obsolete the nomenclature. This is an evil; and one who is disposed to cavil, might lay hold of the fact to the prejudice of the science of geology, on the ground that nothing is settled; that it is a subject of opinions and speculations, and not of facts and principles; of endless details and fanciful hypotheses, which every man has a right to invent for his own or his neighbor's amusement. But such cavillers belong to a race too lazy to observe, too self-conceited to profit by facts, or too bigoted to look at truth when they fear it may conflict with their own notions. They are too obstinate to be reformed; and if they were reformed, they would be of little use to science in any of its departments.

The Primary rocks, comprehending granite, hypersthene, primary limestone, serpentine, gneiss, mica and talcose slates, hornblende, sienite, trap and greenstone, require our attention first of all. They may be tabulated as follows:

PRIMARY.	IGNEOUS	Granite	Composed of quartz, felspar and mica.
		Hypersthene rock.	
		Primary limestone.	
		Serpentine.	
	PLUTONIC	Greenstone and trap.	
		Basalt.	
		Lavas.	
	STRATIFIED	Gneiss	Composed of quartz, felspar and mica.
		Mica slate	Quartz and mica.
		Talcose slate	Quartz and talc.
		Hornblende	Simple.
		Sienite	Composed of hornblende and felspar.

Those portions of the State over which Primary rocks prevail, are the Northern and Southern highlands. Most of the masses enumerated above are found in both these districts. In the northern, which is by far the largest and most important primary district, that peculiar variety of granite denominated *hypersthene rock* prevails very extensively: it forms the highest parts of the county of Essex. Surrounding this mass as an irregular zone, are beds of granite, primary limestone, and a granitic gneiss. This immense mass forms a large portion of the great triangle north of the Mohawk valley. It is here that our granitic soils are formed. The beds, however, of granite and other felspathic rocks which are disposed to decomposition are not very extensive. We have none of the sandy varieties of gneiss or mica slate, which become friable on exposure to the atmosphere, and crumble readily and rapidly into soil. Neither have we much of that peculiar granite which forms porcelain clay, or it is so limited that mere local effects are observed. Primary limestone, associated with granite, and even incorporated with it, exists also, but within such narrow limits that it is unnecessary to notice the peculiar soil which is thus jointly formed. The rocks on the highest parts of the Adirondacks disintegrate very rapidly, and form deposites on the sides of these mountains, which in the progress of time find their way to the valleys.

In estimating the extent of granitic soil, and taking into account all the causes which act in distributing it over the State, I am led to adopt the opinion that it exists only in the immediate districts underlaid by the primary beds, in such quantity as to give the leading characters of a granitic soil. Diluvial action has undoubtedly swept over these districts, and carried to the south some of the soil which once rested upon the mountains and in their valleys, and it has intermingled with other soils more or less; still the quantity bears but a small porportion to that derived from sedimentary rocks. It is true that the materials of these rocks were in many instances of granitic origin, and it is easy often to discern undecomposed felspar in them. Notwithstanding all this, I am not ready to subscribe to the doctrine that all soils are essentially derived from one origin, and that a granitic one; for most of the alkalies are lost in the course of the changes to which the fine particles are subjected. No one, who has observed the soils of New-York, will hesitate to admit that the slate soils are quite different from those of the highland districts.

The same remarks might be made in regard to the Southern highlands. Granitic soil must be confined to the fields underlaid by primary rocks; those which contain felspar and mica, and which furnish by decomposition one or more of the alkalies or alkaline earths. Besides felspar, there are other minerals which are agriculturally important; thus, albite (another variety of the felspar family), mica and hornblende, are each important minerals to be known, or to be sought for in the rock, if we would learn approximately the composition of the soil of a primary district. Thus in Gouverneur and the neighboring towns in St. Lawrence county, a granite occurs, containing considerable albite. This substance contains soda in the place of potash; and hence we might expect this element in granitic soils, especially as this kind of granite is rather disposed to disintegrate.

§ 3. Composition of simple minerals.

The composition of *felspar* and *albite*, together with that of some of the other more common rocks, it may be well to state in this place. The two first named consist respectively of

	Felspar.	Albite.
Silica,	65.21	69.09
Alumina,	18.13	19.22
Potash,	16.66	-----
Soda,	-----	11.69
	100.00	100.00

In attempting to distinguish these minerals from quartz, or flint as it is often called, we are to notice their hardness. Felspar and albite just scratch common window glass, but quartz does not. Albite is always white; felspar is white or flesh-colored, and each give a strong reflection of light from the planes of the crystal; while quartz has the lustre of glass, or more of a vitrified appearance in the mass.

Another kind of felspar is the *labradorite*, which abounds in the rocks of the Adirondack mountains. The rock itself, as already stated, is termed *hypersthene rock*, from a small quantity of this mineral which it contains. The whole mass is mostly labradorite; and by decomposing, it has formed in some places an imperfect porcelain clay. Its composition is as follows:

	Labradorite.	
Silica,	55.75	
Alumina,	26.50	
Lime,	11.00	
Iron,	1.25	
Soda,	4.00	
	98.50	Klaproth.

This species is usually smoke-grey, though the exposed surface of the rock is grey or greyish white: it appears to be bleached.

Mica, another mineral found in granite, gneiss and mica slate, has a composition much like that of the felspars, or at least is analogous to them, as containing two alkalies, potash and magnesia; thus,

	Potassic mica.	Magnesian mica.
Silica,	46.10	40.00
Alumina,	31.60	12.67
Protoxide of iron,	8.65	19.03
Potash.	8.39	-----
Magnesia,	-----	15.70

Together with a variable proportion of oxide of manganese and fluoric acid.

Hornblende, which often replaces mica in the granites, is usually a dark green substance, and extremely tough in the mass. It is commonly crystalline, and more or less fibrous. It differs essentially from the micas and felspar, in containing larger proportions of lime. It consists of

	Hornblende.
Silica,	42.24
Alumina,	13.92
Lime,	12.24
Magnesia,	13.74
Protoxide of iron,	14.59
Oxide of manganese,	0.33
Fluoric acid,	1.50
	98.56

All these substances are termed *silicates;* the silica uniting with each of the principal elements as an acid, and forming thereby silicates of alumina, potash, magnesia, and iron. In the northern as well as the southern highlands, *pyroxene* or *augite* enters largely into the constitution of the primary rocks. Its composition does not differ materially, so far as its effects upon a soil is concerned, from that of hornblende; thus,

	Pyroxene. Light-colored.	Pyroxene. Dark colored.	
Silica,	55.32	54.08	
Lime,	27.01	23.47	
Magnesia,	16.99	11.49	
Protoxide of iron,	2.16	10.02	
Alumina,	0.28	0.14	
Manganese,	1.59	0.61	
	103.15	99.67	Rose.

To the same family belongs the *hypersthene*, which gives name to the rock forming the highest grounds of Essex, namely, *hypersthene rock*. This substance contains less lime than hornblende or augite, and hence is less favorable as an element of soil; in fact, it is remarked, that where it exists in sufficient abundance to influence the nature of the soil, it is quite barren. It is composed of

	Hypersthene.
Silica,	51.35
Lime,	1.84
Magnesia,	11.09
Protoxide of iron,	33.92
Water,	0.50
	98.70

At the north, however, this substance existing in but a small proportion in the hypersthene rock, has but little influence upon the quality of the soil; besides, being mixed largely with labradorite, which contains both lime and alumina, the soil formed therefrom may be considered as good for grains and grass. Quartz or silex, too, is extremely scarce in this rock; and hence there is no excess of sand in it, as there is usually in a pure granitic soil. Hypersthene, upon the whole, may be considered as rather a rare mineral in New-York. It is found in gneiss in Johnsburgh, but in such small quantities that it has no influence upon the soil.

Serpentine is another primary rock, disposed to crumble into soil. It is one in which magnesia is the characteristic element. It consists of

	Serpentine.	
Silica,	40.08	42.69
Magnesia,	41.40	40.00
Water,	15.67	16.45
Protoxide of iron,	2.70	1.00
	99.85 Shepard.	100.14 Vanuxem.

Serpentine may be known by its softness and yellowish green color. It is easily cut by a knife, or easily impressed, and it is always found softer upon the outside than upon a fresh fracture; the color, too, is much paler on the weathered surface.

In foreign treatises on agricultural geology, serpentine is set down with those rocks which make a poor soil. Thus, Johnson speaks of the soil at the Lizard in Cornwall, as being far from fertile, and so retentive of water as to form swamps and marshes; and even when drained, it rarely produces good grass, or average crops of corn. It is the opinion of the same distinguished writer that the barrenness is due to the small quantity of lime contained in the soil; serpentine, as will be seen from the above analysis, being destitute of this element. In New-York, and part of New-England, it would appear that the serpentine exists under different conditions. Thus, in St. Lawrence, Jefferson, Essex and Warren counties, it is intermixed with lime, and the lime disintegrates more rapidly than the serpentine; the soil, therefore, must contain a sufficient quantity of lime. However this may be, there is always a luxuriant growth of vegetables about these beds. The serpentine hills of New-England are not so productive as those of New-York. I allude more particularly to the hills of Chester and Middlefield, along which the great Western

Railway passes. Still, I have seen good crops of rye growing there, though the soil may have derived a beneficial influence from the decomposition of the neighboring rocks composed of hornblende and sienite. Here is also a peculiar vegetation: the *Ilex canadensis*, and some other herbaceous plants, are only found here, and this is the only place where any thing like a pine grove has been planted by nature. For localities where serpentine prevails, see the Report of the Second Geological District.

In this connection, it will be proper to state the composition of *basalt* and *greenstone*, although in New-York they do not form very extensive beds.

	Basalt.	Greenstone.
Silica,	46.50	57.25
Alumina,	16.75	25.50
Lime,	9.50	2.75
Magnesia,	2.25	.....
Soda,	2.60	8.10
Iron and manganese,	20.12	3.50
Water,	2.00	3.00
	97.72	100.10

The composition, however, of these varieties of rock is extremely variable, but all are known to contain the alkalies and alkaline earths; and it is owing to this fact that the greenstone soils are remarkably fertile, so much so that they may often be employed to increase the fertility of less favored ones.

§ 4. Character of granitic soils.

Returning once more to the consideration of granitic soils, I remark, that they are too siliceous and porous when derived purely from granite. Position, however, alters their character; for where they lie upon sloping surfaces, sand predominates; but in the valleys, the fine alumine or clay of the felspar accumulates and forms an admixture of clay and sand, which is more favorable to the support of grass and grain. On reviewing the composition of the minerals which enter as elements in rocks, we find that the most abundant of them contain the proper proportions for a good soil. Silex rarely forms less than one-half; the remainder is made up of alumina (which is essential to the consistency of the soil), lime, potash, soda and iron, some containing more and some less of each respectively, the alkalies being the most essential, and rendering a soil rich, as it is termed, in proportion to their amount. In addition to the fact here stated, I may observe that the tendency to decompose is also increased in proportion to the percentage of the alkalies contained in the mineral: a rock of pure quartz is acted upon very slowly, while one in which felspar and mica exist crumbles rapidly.

In applying the preceding facts, it is easy to see how farms and estates should be selected in a primary district. The depth of soil is an important fact, as is well known, but its derivation is another equally important. For its determination, the outcrop of rocks upon hillsides may be examined, and their nature ascertained; whether their exposed or weathered surfaces are bleached, and softer than that of a recent fracture; or whether they are crumbly, and disposed to disintegrate. If the rocks are hornblende or pyroxenic greenstone, or a coarse granite with large masses of felspar, we shall expect the soil to contain the alkalies or alkaline earths; and if by cultivation they become exhausted, we may expect that by deep or subsoil ploughing a fresh quantity can be brought to the surface for the use of vegetables, and thus a constant reproduction of them obtained from the decomposition of the coarser particles now intermixed with the deeper soil. Greenstone and trap, from their more ready disposition to undergo change, may be ranked among the best materials for a foundation soil, possessing all the requisites desired for the cultivation of grains and fruits. They are not so porous as the granitic sands that are termed *leechy;* nor so compact as many of the argillaceous soils, many of which retain the water in pools upon the surface.

§ 5. Drifted soil.

A farther consideration of the causes which have distributed the soil and spread the debris of rocks at a distance, is of some importance while treating of the northern counties; as it may appear to those who are familiar with the drift or diluvial theories, that little reliance can be placed on our instructions for determining the character of the soil by observing the rocks beneath. It is true that we find the debris of distant rocks in most of our soils; yet we find that their essential character is, with some exceptions, derived from the rock near by. On the northern and northwestern slope of the highlands in Franklin county, many boulders of Trenton limestone may be found, which, together with some of the finer matters, were brought from the Canada side, and probably this transported debris exerts some influence; still there is a predominance of soil from the Potsdam sandstone, the underlying rock of a great part of the county, particularly the northern part. In the neighborhood of Malone, immense drift beds have been accumulated, in which the boulders of this sandstone always predominate. They have also been transported south, and lap on to the primary masses, and modify the soil of the granite and gneiss; but when we penetrate deeply into this great primary region, its distinguishing characters are derived from the masses beneath. In some instances the drift current has left nothing but loose boulders, which, resisting decomposition, all the soil we now find is of modern or recent origin. Narrow formations, whose strike is east and west, will usually be covered with a more distant soil than those whose strike is north and south. Of this fact, we shall have occasion to speak hereafter.

Little need be said of the northern highlands in regard to structure. The country being either mountainous or hilly, almost the whole surface is properly drained, or else is easily drained where, from local causes, water may be retained in the subsoil. The valleys are narrow, the hills abrupt, and there is no necessity of searching the peculiar structure of the rock to open a passage for stagnant water. The spontaneous growth of grass is the most interesting fact; the country being best adapted to pasturage, or the keeping of stock for wool, butter and cheese.

This district is, however, broken by the steepest and highest precipices in New-York, or indeed in all the Atlantic or Middle States. The Adirondack pass is a giant precipice. It is feebly represented at the head of this chapter, for it is only a feeble representation which the pencil can give. To be conceived, it must be seen. Many minor precipices break up the country at the sources of the Hudson, and thus diminish its value as an agricultural district.

CHAPTER V.

THE TACONIC SYSTEM.

MOTIVES OF THE PRESENT INVESTIGATION. OPINIONS OF GEOLOGISTS RELATIVE TO THE TACONIC AND CAMBRIAN SYSTEMS. RELATIONS AND CHARACTERS OF THE HUDSON RIVER ROCKS. ROCKS BELOW AND OLDER THAN THE TACONIC ROCKS. POSITION AND RELATIONS OE THE TACONIC SYSTEM. INDIVIDUAL MEMBERS OF THE TACONIC SYSTEM; THEIR LITHOLOGICAL CHARACTERS, FOSSILS, SUCCESSION AND THICKNESS, IN NEW-YORK, MASSACHUSETTS AND VERMONT: BLACK SLATE; TACONIC SLATE AND ITS SUBORDINATE BEDS; FOSSILS PECULIAR TO THE TACONIC SLATE; SPARRY LIMESTONE; MAGNESIAN SLATE; STOCKBRIDGE LIMESTONE; BROWN SANDSTONE OR GRANULAR QUARTZ. ROCKS RESTING UPON A PORTION OF THE TACONIC SERIES. THE TACONIC SYSTEM IN MAINE, RHODE-ISLAND AND MICHIGAN. DERANGEMENTS. MINERAL PRODUCTS. REFERENCE TO PLATES XIV. XV. XVI. AND XVII.

I. GENERAL VIEW OF THE TACONIC SYSTEM.

§ 1. Preliminary remarks.

In consequence of the rejection by Prof. Rogers of a system of rocks which I have denominated the *Taconic System*, I have been induced to reëxamine all the facts and arguments upon which it is supposed to rest. The medium through which Prof. R. has made known his views and the results of his examination of this system, is his Address before the American Association of Geologists and Naturalists, at their late session in Washington city, in May of the present year (1844), which address is published in the American Journal of Science for July. As my examination, at the time my New-York Report was published, had been confined to New-York, Massachusetts and Vermont, or to the range of hills and mountains extending north from the highlands of the Hudson into Canada, and known as the Taconic and Green Mountain range, I deemed it necessary that an examination should be made also of other fields where the same system of rocks was indicated. Accordingly this last summer I extended my researches into Rhode-Island and Maine. I have not, however, been content with these visits, but have reëxamined numerous localities in the fields where my earlier investigations were made. With the additional facts thus acquired, I feel prepared to lay before the American geologists the results of my observations. In doing this, my design is to present them not only with the additional evidence I have recently acquired of the truth of my former position respecting this system, but also, as far as circumstances will permit, with the whole evidence in regard to it. I do this for the purpose of correcting some errors, and elucidating the subject more fully, as well as making it of greater value to American geology. In the following pages, I believe the reader will be satisfied that in these rocks we have, for this country at least, the true *palæozoic base*, and that in them exists those organic forms which are strictly entitled to the designation *protozoic*.

§ 2. Opinions of geologists on the taconic and cambrian systems.

The published opinions of geologists in regard to the Taconic rocks, it is deemed will be of sufficient interest to merit a transcription in these pages. I give them in the order of their publication. The first, then, is from the Report of Prof. Mather, one of my colleagues in the New-York Survey, who, in his preface, has penned the following paragraphs:

"The views of one* of my colleagues are different on some of the problems of geology, as I have just learned by seeing his published works. Time will determine who is right; and the author, if wrong, will without hesitation yield the point. Prof. Emmons has discussed the long vexed question of the age of the Taconic rocks (the peculiar slates, limestones, etc. along the eastern line of New-York from Lake Champlain to the Highlands). He has the advantage of having lived on and among them, and of exploring them with much minuteness during many years; and probably every geologist, from examining them where he has, would arrive at the same conclusion as to their age. He admits that they are not found at any locality resting on the primary, but that the Potsdam sandstone is the lowest known rock resting upon that formation.

"Prof. Hitchcock, the Geologist of Massachusetts, has also entered into a discussion of the age of the Taconic rocks, as they occupy some space in the western part of Massachusetts. His observations, and those of Prof. Dana, have long since drawn the attention of geologists to these rocks. Prof. H. views these rocks as metamorphic, a conclusion entirely opposite to that of Prof. Emmons; but he could find no data from which to infer their age or place in the geological series. Both these gentlemen, Profs. H. D. and W. B. Rogers, and various other geologists, have come to the conclusion that these rocks, and in fact most of those from the Hoosic mountain range to the Hudson, have been wrinkled up and folded over, all in one direction, so as to give the same direction of dip; and I concur with them in this opinion. My own observations on these rocks, and those of the Hudson valley, conducted with much care through their whole extent in New-York,

* By personal inquiry, Mr. Mather informed the author that he was the colleague referred to.

and in Vermont and Massachusetts, through a series of years, have led me to the conclusion that they are metamorphic, and of the age of the Champlain division; that they are the altered limestones, slates and sandstones of that division.

"The white limestone containing plumbago and various crystallized minerals, is another point on which there are various views. I have come to the conclusion that it is metamorphic."

The following extract from Prof. ROGERS's Address before the American Association of Geologists and Naturalists, at Washington, in May, 1844, sets forth the same opinions:

He proceeds (Journal of Science, p. 150), "Let us inquire how far we in the United States have proceeded in the same labor, of firmly establishing some of the more important limits between the several portions of geological time as recorded by our strata, and their organic remains. And first, let us examine the conclusions reached regarding the commencement or dawn of the whole fossiliferous period. The fixing of a base for the palæozoic rocks of the United States, is a problem scarcely less difficult than that of determining the lower limit of the corresponding system in England, to which the admirable sagacity of Sedgwick has been so usefully directed. Do we possess in the so-called *Taconic system* of rocks lying to the southeast of the unequivocally fossiliferous strata at the base of the New-York or Appalachian system, an independent mass of formations of an unquestionably earlier date; or are these, on the other hand, but well known lower Appalachian strata, disguised by some change of mineral type, and by igneous metamorphosis? These Taconic rocks, under the form they assume along the eastern boundary of New-York, and western side of Vermont and Massachusetts, have been carefully studied by Emmons, Hitchcock and Mather, all of whom appear to have arrived at different conclusions concerning them. Since the same or a very analogous group of strata ranges at intervals, holding the same relative position, the whole distance from Vermont to Georgia, the question of their age, while it has a wide bearing on any general classification of our formations, ought certainly to admit, sooner or later, of settlement, when so many and such noble transverse sections are opened to inspection by the river gorges which cut the Blue ridge.

"Prof. Emmons considers the granular quartz, slate and limestone of the Taconic hills and the Stockbridge valley, as constituting a distinct group of strata, neither appertaining to the true gneissoid or mica schist system on the east, nor to the palæozoic fossiliferous rocks of the Champlain and Hudson valley on the west, but holding an intermediate place in the scale of time.

"This identity of the so-named Taconic system, with the formations of the Hudson and Champlain valley, was announced by my brother and myself, in the beginning of 1841, to the American Philosophical Society. By the aid of a section from Stockbridge towards the Hudson river, we showed the existence of numerous close anticlinal and synclinal folds, and thus explained the apparent inversion of the dip, which other geologists had ascribed to one general overturning of the whole series. The plication was shown to be greater along the Berkshire valley and the ridges east; the granular Berkshire marble was identified with the blue limestone of the Hudson valley, but metamorphosed by heat; and the associated micaceous, talcose, and other schists were referred, in the language of the communication, to the slates of the lowest formation of the Appalachian system, while the semi-vitrified quartz rock of the western part of the Hoosic mountains was stated to be nothing else than the white sandstone (Potsdam sandstone) of the same series slightly altered. I am gratified to find from Prof. Mather that these views of identity are embraced by him, as they now are, if I mistake not, by Prof. Hitchcock. Prof. Mather indeed says that he has traced this slate (Hudson slate) through all its gradations into talco-argillaceous and talcy slate, and into graphic and plumbaginous slate; the limestone from compact, sandy and slaty, to sparry, slaty, talcose, and crystalline limestone, within short distances, and the Potsdam sandstone to a hard compact and granular quartz rock. It is true, Prof. Emmons has presented in his report a series of sections of the strata, exhibiting an unconformity at the passage of his Taconic into the rocks of the Champlain division; but I must take the liberty of expressing my disbelief of the existence of any such unconformity, and of observing that in the prolongation southwestward of this altered and plicated belt as far as the termination of the Blue ridge in Georgia, a distance of one thousand miles, no interruption of the general conformity of the strata has ever met the observations of my brother or myself."

Prof. Rogers then goes on to say, that the Potsdam sandstone forms the base of the palæozoic strata in the latitude of Lake Champlain, or at least in the region of the Mohawk river; and that although there are members of the same family expanded downwards in a conformable position in some portions of the Blue ridge district, still the white or Potsdam sandstone is yet the most ancient depository of organic life hitherto discovered in our strata. We have, then, in the above extracts, Prof. Rogers's views of the Taconic system, which may embrace a few beds older than the Potsdam sandstone; but as these beds are conformable to whole and entire series above, they are by no means entitled to the rank of an independent system.

Having now shown how little favor the Taconic system has received from the opinions of American geologists, I deem it proper to lay before the reader the opinions of some European geologists upon what I consider to be, at least in part, the same system, though known under the term *Cambrian*. All I have to say in this place in regard to the existence of such a system in Europe, is to state the conclusions of geologists in relation to it; and this I propose to do by extracts from the Address of Mr. Murchison, President of the Geological Society of London, delivered at the Anniversary Meeting on the 18th of February, 1842. Omitting several paragraphs which relate only generally to the subject, I commence with the following:

"If then our researches teach us that the term *Cambrian* must cease to be used in zoological classification, it being in that sense synonimous with *Lower Silurian*, we see the true value of having established a type like the latter, which being linked on through intermediary groups to overlying formations, the age of which was previously well known, we have arrived *gradatim*, and without hypothesis, at the apparently true base of the zoological series in Europe. It is right, therefore, that I should announce that the conventional line which was set up in the map of the Silurian region, between the Lower Silurian and Cambrian rocks, and which has been adopted by Mr. Greenough, has no longer any reference to strata identified by distinguishing organic remains; for the same fossils are found in strata on each side of that demarcation. Such lines of division, however, when viewed as signs of local phenomena, are notwithstanding highly useful, both as indicating changes of lithological character, great lines of disruption, and lower divisons of the same palæozoic group. In short, all researches up to this day have led to the belief that the Lower Silurian fossils were the earliest created forms; and that this protozoic type prevailed during that vast succession of time which was occupied in the accumulation of all the older slaty rocks, until the Upper Silurian period, when new creatures were called into existence, and when the earlier forms diminished, and were succeeded by a profusion of chambered shells which so abundantly characterize that epoch. This is, I trust, a good step gained. To establish upon sound data the true theory of organic succcession in the oldest forms of life, is surely important; *and we ought to rejoice that British islands have afforded us the means systematically to work out the question.*"

It is needless to remark in this place upon the announcement of the abandonment of the Cambrian system. Suffice it to say that the fact is explicitly declared, and the society is congratulated that a step is gained in geology by the final settlement of an important question; and were it not for a single fact, the writer would freely acquiesce in the decision, so far as British rocks are concerned. This fact is found in the existence of peculiar fossils on both sides of the Atlantic, which, so far as discoveries have yet been made, are confined to the slates of the Cambrian and Taconic system; and now the great object of the writer is to show that the above question has not been settled right, or according to facts; or, in other words, that the Taconic rocks are not the Hudson river slates and shales in an altered state, or that all the Cambrian rocks are not Lower Silurian.

§ 3. Relations and characters of the Hudson river rocks, embracing also the Champlain division of the New-York system.

Before proceeding to that part of my work in which I design to describe the members of the Taconic system, it will be useful and proper to lay before the reader a brief view of the Champlain division of the New-York system, as it embraces what have been denominated the Hudson river rocks; for it is by a correct knowledge of these masses, that we obtain the necessary facts upon which to decide the question *whether we have a Taconic system or not.*

In 1838, in my report for that year, I stated that the Potsdam sandstone was the oldest sedimentary rock in Potsdam and its vicinity, and that no rock intervened between it and the primary. This statement has proved true. On page 230 of the Report for the same year, it will be found that a sandstone in Essex county was determined to be the same as the Potsdam, and that it is succeeded by the Calciferous sandrock of Eaton.

The New-York system commences, then, with the Potsdam sandstone; a rock far from being homogeneous in its composition, but consisting mainly of three portions, a conglomerate at base, an even-bedded sandstone in the middle portions, and a mass of siliceous dark-colored slate with fucoids at the superior portion. Its lithological characters are not uniformly the same. The conglomerate is sometimes wanting, or is imperfectly developed, and it also contains irregular beds of breccia in which there are masses of grey sedimentary limestone; a fact which is not to be forgotten. Besides these, there is a mass of coarse dark-colored sandstone, traversed or checked by thin seams of grey quartz. This last mass is well developed toward Champlain in Clinton county. The conglomerate along the Provincial line of New-York and Canada East, is more than three hundred feet thick. This thick mass thins rapidly southwardly; and in the valley of the Mohawk, the entire mass of sandstone, as well as the conglomerate, has disappeared. In the absence of the Potsdam sandstone, the succeeding rock, the Calciferous sandstone, rests frequently upon the Primary system, as at Littlefalls. The fossils of this rock are fucoids, and a single species of *Lingula*; the latter are in great abundance at the High bridge near Manchester upon the Ausable. The same shell occurs at French creek upon the St. Lawrence.

The rock succeeding the Potsdam sandstone, is, as has already been stated, the *Calciferous sandrock* of the late Prof. Eaton. This too, is one extremely heterogeneous in its composition; consisting of a grey sandy limestone, a white but quite siliceous limestone, two or three encrinal masses which are nearly pure limestones, and often with layers fit for polishing, and which form a tolerable handsome reddish marble. The most extraordinary mass, however, is a reddish sandstone, with thin inconsiderable layers of slaty laminæ: if traced upward, it becomes a tolerably pure limestone, stained slightly with iron, but sometimes white. Layers from eighteen inches to two feet thick of black chert often appear, and alternate with the grey sandy variety. In addition to the above, we frequently meet with layers charged with fine quartz chrystals, intermixed with calc spar, sulphate of barytes, sulphuret of iron, etc.

Another mass, the place of which is very doubtful, is a brownish tough sandstone, lying beneath all the other masses composing the Calciferous sandstone. The question in regard to this mass, is whether it is to be considered as an equivalent of the Potsdam sandstone, or as belonging to the succeeding mass, the Calciferous sandstone.* The determination of this question is, however, of no importance to the subject under discussion; yet the mass is in a few places an important rock, as at Mount Toby in Washington county, where it is one or two hundred feet thick. This, together with the red sandstone just spoken of, I am sometimes disposed to consider as equivalents of the Potsdam sandstone. Perhaps it would be better, however, to regard them as intermediate masses, so long as there are no decisive characters on either side.

As my object now is merely to state very briefly the order of succession of the lower New-York rocks, I have only to say, that from the Calciferous sandrock upwards, there is a series of limestones described in the New-York Reports as Chazy, Birdseye and Trenton limestones; all of which, together with the black marble of Isle La Motte, are largely formed in Northeastern New-York. It appears, also, according to Dr. Troost, that the same limestones are found in East Tennessee, with the same fossils; a fact of great interest, as it sustains the position assumed in the Report of the Second District, namely, that the Chazy rocks are not simply local interpolations, but may be considered as well defined general masses.

Still proceeding upward in the New-York series, we now have reached those slates and shales which have been denominated the *Utica slates*, and *Hudson-river* or *Pulaski shales*. The first is really a black calcareous shale. The succeeding mass is more or less sandy, and finally terminates in a thick-bedded sandstone interlaminated with a dark-colored slate. The whole thickness in New-York, at the termination of the Helderberg range towards the Mohawk valley, is not far from seven hundred feet.

I have no occasion to extend this descriptive list of the lower rocks of the New-York system farther. The succession is clear and unequivocal, determined directly by superposition; a superposition which may be at once seen by any one who will travel across Jefferson county from north to south. The Potsdam sandstone is here the inferior mass: it gradually passes into the Calciferous sandstone; and in both rocks there is a species of *Lingula*, either identical or so closely allied as to be distinguished with difficulty. The bearing of this fact will be stated more fully hereafter. I may, however, say in this place, that it entirely dissipates the notion advanced by Prof. Rogers, that the Potsdam sandstone of the New-York system and the granular quartz of the Taconic system form one identical rock.

The lower rocks, those now under consideration, are the only ones which, either in this country or Europe, have ever been termed the *Metamorphic rocks*, or have ever been confounded with those that I have called the *Taconic rocks* or *system*. Some of them are unquestionably equivalent to the Caradoc sandstones of the Silurian system. The Medina sandstone, which succeeds the Hudson river rocks (black and grey shales and a thick-bedded sandstone, with the Utica conglomerate at the superior part), is no where found in the vicinity of the Hudson river; but here they are immediately succeeded by the thin greenish and reddish shales, which finally pass into the thin-bedded limestones called in the New-York reports the *Manlius water-limes*.

Having stated very succinctly the order of the lower palæozoic rocks of the New-York system, I deem it unnecessary to follow up the succession, inasmuch as there is scarcely a possibility of confounding the Helderberg division with the Taconic system, and inasmuch too as it is admitted by all who dissent from my views in regard to this system, that it is the lower division only which is metamorphosed into that long belt of slates, shales, crystalline limestones and sandstones lying between the Hudson river on the west and

Hoosic or Green mountain on the east. The succession of this lower division is represented by an actual section extending from Glen's falls five miles northeast, or to the primary upon which the Potsdam sandstone rests.

Fig. 1.

a. Granite; *b*. Potsdam sandstone; *c*. Calciferous sandstone; *d*. Trenton limestone; *e*. Black marble, extending towards the river.

The gorge at this place is not sufficiently deep to expose the Potsdam sandstone, but the succession is well exhibited in passing over the country in the direction stated above. The Utica slate at the falls has been mostly destroyed by denudation; but it appears both above and below, upon the river banks, with its characteristic fossils, succeeding the Trenton limestone.

The point to be shown, is that the lower division of the New-York system reposes upon some of the members of the Taconic system; that is, to show by actual superposition that the former rests upon the latter. I trust I shall be able thus to do: not only to point out where the two systems approach each other so closely that there is but little space intervening between them, but where the finger may be placed directly upon the line of demarkation; the one being the inferior and unconformable, and the other the superior. This great fact being shown, its bearing on American geology is not confined to one or two subjects, as metamorphism and age; but it is also important as furnishing a base from which may be formed a general nomenclature of sedimentary rocks. At any rate, it is a point to be established before a nomenclature can be devised, that shall express the order in which the series follow each other, and the designations proper to apply to them.

§ 4. Rocks below and older than those constituting the Taconic system.

In Massachusetts and Vermont, as well as in New-York, what has been usually denominated the *Primary range* skirts the Taconic system upon the east, and forms with it parallel belts of low mountain ridges, which unitedly form the Green mountains. Different portions have received different names; as Hoosic mountain, immediately east of Adams in Berkshire (Massachusetts); and Mansfield mountain, to the east of Burlington (Vermont).

The Taconic range is parallel with the main ranges constituting the Green mountains, and is a few miles only to the west. The ridge dividing New-York from Massachusetts is the one to which this name was originally given. The ranges are, however, connected by spurs, though not so intimately as to destroy the integrity of either, and make it necessary to merge them both in one main range. The name *Green mountains* is a more general term, and often covers both ranges. But keeping up the distinction denoted by the subordinate portions of the most easterly range, as Hoosic and Mansfield mountains, and the Taconic range upon the west, we shall find that the geological character of the two are quite dissimilar, and well worthy of observation on that account. The former are the great primary or schist ranges, the subordinate members of which are gneiss, mica and talcose slate, and hornblende, among which are many beds and veins of granite, limestone, serpentine and trap. There is no clear line of distinction between the schistose rocks: mica slate is the predominant rock, in connection with which we find gneiss and talcose slate and hornblende, and with the two last are the serpentine and steatite beds, which in some instances are beds of passage; for instance, the great beds of steatite in Middlefield and Chester pass into talcose slate and serpentine.

The principal object in speaking of the schists, is to bring into mind their position and character. Situated to the east, running in parallel ridges with the Taconic range, and being composed in their entire length of schistose masses, we are furnished thereby with the probable reason why the lower masses of the Taconic system are so perfectly schistose also: *the latter are derived from the former;* the abraded materials of the one make up and constitute the consolidated masses of the other; they are the first products from the primary rocks; the sea in which these materials were deposited was the most ancient, with little carbonaceous matter, and probably with a temperature rather above the present seas; the masses are less changed in color and aspect; and being crystalline, also, the lower slates of the Taconic system appear like those of the older schists of the Primary system: they are regenerated rocks, possessing the characters belonging to the parent beds from which they are derived. The fact is notorious that the talcose slates of Berkshire are like the talcose slates of the Hoosic or Green mountains; and yet a close inspection of the two ranges of schistose rocks will satisfy most geologists that they are not of the same age, or of the same system.

That it is possible for a sedimentary rock to retain or assume the characters of the parent rock, is rendered highly probable by the characters of the rocks or slates connected with the Rhode-Island coal beds. Here, in connection with the conglomerate probably of the Old Red sandstone, there is much material which is a talcose slate, differing but slightly from the talcose slate of the Taconic system; or, in other words, it is like that of Berkshire county. I conceive that the slate of the Old Red, and which I believe Prof. Hitchcock calls *wacke slate* in his Massachusetts Report, is one derived directly from the magnesian slate of the Taconic system lying in proximity thereto: the quartz pebbles are evidently of that kind of quartz in the same rocks. The beds of conglomerate, with which these slate beds are in connection, do not appear to be metamorphic: the whole seems to be merely indurated or hardened slate, the original particles being talc and mica, with some fine quartz. The rock, when complete, is merely an ordinary talcose slate.

I do not, however, deem it essential to prove the origin of the rocks which happen to lie in the ranges belonging to the Taconic system. It is of little consequence what the lithological characters of any of its members are; still I consider that it tends to remove objections from the minds of some, to show how it happens that we find slates in the Taconic system so similar to those of the Gneiss or Primary system. If, however, the doctrine I have advanced in relation to the origin of these slates is objected to, or is not admitted as sound, I will ask on my part how it happens that talcose slate is found in the conglomerate of the Old Red sandstone? If there is any better answer than the one I have given; if there is a better doctrine, let us have it. I say that if talcose slate, a sedimentary mass, can be made in the era of the Old Red sandstone, I see no objection to its being made at an earlier period by the same process.*

§ 5. Position and relations of the taconic system.

There is but one point which it is necessary to show, in order to prove that the Taconic rocks belong to a different period from those of the lower New-York system; and this being proved, the doctrine of metamorphism, as usually applied and understood, is no longer important, or even of any consequence. The Taconic rocks may or may not be metamorphic; this may be admitted, or it may be denied: it has nothing to do with the question. Their texture may have been changed since their deposition; but if so, it by no means follows that they are of the period of the Hudson river slates, or of the lower Silurian rocks.

In proceeding to show the position of the Taconic system, I shall repeat in part the facts stated in my report on the geology of the northern counties; inasmuch as after a reëxamination, I find but few instances in which I have had occasion to make corrections. These

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* In these remarks, as I have touched lightly upon the coal-field of Rhode-Island, I will permit myself to wander a little farther from the immediate subject of this essay. The doctrine that the anthracite of this small basin is a metamorphic coal, has been promulgated by some of the ablest geologists of this country and of Europe, particularly by Mr. Lyell. The hypothesis is, that the bitumen which it is supposed once formed a component part of these beds of coal, has been dissipated by heat, or, in other words, *burnt out*. To this doctrine the writer is not yet ready to yield his assent, for the following reasons: 1. The slates and conglomerate bear no marks of the action of heat (I speak only of those which I have seen). The fossils are similar in texture to those of other coal-fields, and they are perfectly free from all marks of fusion or induration by caloric. The *Calamites* are often in what some would call a talcose slate; not so from heat, however, but in consequence of its origin. 2. If the bitumen was discharged by heat, then ought the sulphur of the sulphuret of iron also to have disappeared. 3. If sufficient heat had been applied to volatilize the bitumen of the coal, then ought the slate also to exhibit marks of having been burnt. But it is said, farther, that the coal is changed into graphite. Admitting the fact, does it prove that heat was the agent of this change? It does not necessarily follow, inasmuch as cast iron changes into graphite without this agency. The doctrine I wish to maintain, is, that if the coal has been thoroughly baked so as to dissipate all its volatile matter, then ought the rocks embracing the coal to exhibit signs of having been baked or burnt. In this connexion, too, I would inquire, if in the original formation of coal-beds, bitumen is a necessary element, one that will be invariably produced? Admitting that bitumen is not a necessary product, does the coal of Rhode-Island possess characters so different from the western bituminous coal, that they cannot arise from pressure or other mechanical agencies? The strongest evidence I have seen of the igneous action, is in the existence of seams of quartz, traversing the coal; not that they are injected in a melted state, but deposited from hot water or aqueous vapor holding silex in solution.

occasions arise from having placed too much reliance upon lithological characters, which it must be admitted are remarkably similar to those of the Hudson river shales, and the primary schists. Thus upon the east, in the range of Graylock, are those slates which have usually been denominated *talcose*, and sometimes *mica slates*. If lithological characters alone are relied upon for determining their age and position in the series, some geologists might place them in the Primary; and then again those upon the west, in the vicinity of Hudson river, might, without doing violence to the same characters, be placed with the slates and shales of the Champlain division. On the principle of giving to the Champlain division those rocks which resembled its own members, and to the Primary system a similar title, we might divide the Taconic system into two great divisions according to their respective lithological characters. Such a division, however, can by no means be admitted, for reasons which will be stated hereafter. I may state, however, that geologists, by allowing too much importance to lithological characters, have overlooked the Taconic system. In this connection, too, I may remark, that it is important, when it is wished to determine the amount of alteration which a mass has suffered, to ascertain its origin, or from whence its materials were derived; and also that it will be rarely essential to prove, or admit, that it has been exposed to an intense heat; for steam, or hot water charged with silex or other soluble bodies, are competent to produce great changes in a mass. Thus in the Cumberland coal-field of Rhode-Island, the coal is traversed by seams or veins of quartz, veins which we do not feel disposed to admit were injected in a state of igneous fusion, but were rather deposited from a vapor or water holding silex in solution.

I shall take the broad and distinct ground that the Taconic system occupies a position inferior to the Champlain division of the New-York system, or the lower division of the Silurian system of Mr. Murchison. In order to prove that this position is well chosen, it will be necessary to refer the reader to localities where one system of rocks reposes upon the other; and that I might set this beyond the possibility of a doubt, I have sought those points where the slates of the Taconic system come in contact with the lower limestones, or with the Potsdam sandstone of the New-York system.

With these objects in view, I commenced my examination at Whitehall. This I considered a favorable place for the exhibition of the fact sought, since here the Utica slate and Hudson river rocks are wanting. The New-York series commences with the Potsdam sandstone, which rests on gneiss, and extends upwards so as to embrace merely the Calciferous sandrock, and perhaps a very small remnant of the Chazy limestone. The rocks dip eastwardly at an angle ranging from $2\frac{1}{2}°$ to $5°$. On being traced in the direction of dip along the sides of the uplift, they were found to extend two and a half to three miles only from the lake, and to attenuate rather rapidly; so much so, that they are cut through in several places, leaving the easterly portions separated from the great mass at the west. In these deep cuts the Taconic slate is denuded, and exposed in its steep southeasterly dip. More than this, the immediate line of contact is exposed at one of the ravines in rear of

Whitehall mountain, so that all doubt in regard to its position and relation is removed by direct inspection.

The diagram in Fig. 2 illustrates the position and relations exhibited at Whitehall.

Fig. 2.

a, a. Easterly prolongation of the mountain, which is surmounted by the Calciferous sandrock; *b, b.* Tertiary clay; *c, c.* Taconic and black slate; *d, d.* Calciferous sandstone, unconformable to the Taconic slate, and dipping southeast at an angle of 40–45 degrees.

From this exposition, no one can doubt the wide difference in age between this slate and those of the Hudson river; the former being below the oldest members of the New-York system, while the latter rest conformably upon the middle members of the Champlain division. The Taconic or black slate, the newest member of the Taconic series, was not only deposited anterior to the other under consideration, but was disturbed or removed from the horizontal position; and its deposition and disturbance seem to mark the close of one geological period of great duration, if we may judge from the united thickness of the rocks belonging to it.

Another section (Fig. 3), differing but little in detail from the preceding, but exhibiting more fully the relations of these systems, is annexed.

Fig. 3.

Near a church three miles east of Whitehall, is a deep ravine in which the Taconic slate, *d, d,* is denuded; *a, a.* Calciferous sandstone.

Another section (Fig. 4), passing through the slates and shales of the Hudson river as well as the Taconic slates, is taken from the hills of Greenbush opposite the city of Albany.

Fig. 4.

a. Tertiary clay; *b.* Hudson river shales; *c, c.* Taconic slate; *d.* Calciferous sandstone.

Passing east from the ferry, the first rocks are the shales of Hudson river, overlaid by tertiary clays: these continue to the Red mill. Leaving the mill, the rocks are concealed till we reach the summit of a low range of hills bordering the eastern side of the valley of the Hudson.

The summit is marked by rather rounded hills, of sufficient magnitude to break the continuity of the plain. One of these hills, nearly east of the ferry, is crowned by the Calciferous sandstone: it has a sugarloaf shape; descending, however, more rapidly upon its western face. Through this hill the section passes; and here we find the taconic slate outcropping upon the western side directly beneath the limestone, and but a few feet distant from it. Some diversity of opinion may arise in relation to this small mass of limestone being the Calciferous. My reasons for regarding it as such, are, 1st, It is lithologically so: it is geodiferous: its geodes contain the quartz crystals and the peculiar anthracite; and, 2dly, a few of the fossils are either those of the Calciferous or the Chazy limestone, for I have found the *Maclurea* here. Then again its position is that of the Calciferous sandstone: it is the inferior rock where the Potsdam is absent. But at this locality we find other fossils quite similar to those of the Trenton limestone; the *Bellerophon bilobata*, or the same which is credited to the Trenton limestone. But what is quite remarkable, I found masses bearing the character of the Birdseye limestone. All these facts put together indicate that this mass of limestone is a mixture of all the lower limestones of the New-York system; that they meet in this mass, though it is by no means extensive. But this view is not adverse to the position I take, namely, that the slate beneath is older, and belongs to an older system, inasmuch too as it is unconformable to it.

An interesting fact is exhibited at Whitehall, in the position or relations of the Potsdam sandstone. At this place it may be traced continuously to the gneiss on the western side of the mountain, and dipping to the east. We trace it upward into the calciferous sandstone, whose thickness here is at least two hundred feet. But a mile or two to the east we find in the deepest ravines the outcropping of the black or taconic slate, which plunges rapidly downwards on the western face of the rock. Now it is highly probable that the slate is continued farther west than what appears in the outcrop, so that it probably passes beneath the Potsdam unconformably, as we know it does beneath the prolonged Calciferous sandstone. If this view is correct, the lower member of the New-York system, the Potsdam sandstone, rests or reposes upon two systems: on the western margin, upon gneiss, and the Primary system; and on the eastern margin, upon the Taconic system.

But an important inference may be drawn from the relations of the potsdam at this place, namely, that it is not the granular quartz of which much has been said in the Reports of Prof. Hitchcock, and in the geological papers of Prof. Dewey, or No. 1 in part of the Pennsylvania and Virginia Reports. I say *in part*, because Professors Rogers in their No. 1 include both the Potsdam sandstone and the Granular quartz; for if these masses are one and the same, the slate one and a half miles east ought to rest upon the Calciferous sandstone; and there is no space for the slate to come in between the calciferous and potsdam, as they are conformable to each other, and the whole western face of the hill or mountain is an exposed cliff, where every inch of rock from top to bottom can be seen. At this place, it is true, there is a thin band of siliceous slate; but it is *in toto* distinct from the argillaceous slate a short distance to the east. This band is an accidental deposit: it is sometimes present, but frequently absent; while the argillaceous or green taconic slate is a rock of immense thickness. Where the siliceous band is wanting, the potsdam sandstone passes by imperceptible grades into the calciferous, the calcareous matter gradually increasing. The only view, then, which can be taken of these two masses, one of which was invariably below the Calciferous sandstone, and the other below a grey slate near the Primary schists in this section of country some twenty miles to the east, is that they are totally different rocks, or belong to distinct eras; and yet lithologically they are much the same, and in position lie at the base of two distinct but successive systems.

A few words more in regard to the Calciferous sandstone. This rock is sometimes associated with a mass of compact blue limestone, more pure, though of a darker color, than the common variety. It occupies a position usually inferior also to the common calciferous sandstone. That it belongs to that rock, however, there can be no doubt, as it often passes into it; yet in some places it is exceedingly obscure in its relations. Its stratification also is so imperfect, that it is impossible to decide with confidence whether it has any. It is compact, though imperfectly jointed, and is always traversed by seams of white spar. At one locality the blue mass beneath becomes incorporated with the grey mass above; but the layers on one side are marked by lines of deposit, which suddenly stop, and the mass on the adjacent side is entirely destitute of planes of deposit. This locality is Galesville, Washington county; a locality, which all who doubt the soundness of my views will do well to see and examine. They will here find the lower limestone resting, as at many other places, upon a slate.

The extension of the Calciferous sandrock east can not be marked by a continuous line: it often seems to depend upon the amount of denudation and destruction the rocks have suffered. It appears too only in patches, and never in uninterrupted masses for any distance. Generally in these instances it occupies the highest hills, or the knobs, and occasionally extends down upon the eastern or northeastern sides. Whatever may be its position, however, it is never interlaminated with the slates of the vicinity: it never dips into, but reclines upon them.

Mr. Hall, my colleague, is disposed to regard some of these masses of limestone as appertaining to the Trenton. This view does not affect unfavorably the question whether there is a system of rocks beneath the New-York system; for at all those localities it is clearly the oldest mass of this system, and it reposes unconformably upon a still older deposit of slates. It hence matters not what name we give them: the fact has no exception.

To the north, and perhaps the whole length of Lake Champlain, the Calciferous sandstone lies in a more continuous north and south line than in the immediate range of the Hudson. From Whitehall south as far as the Southern highlands, we meet with it usually in detached beds occupying the hills. Along this range is the great north and south fracture, which has elevated these hills in a line almost continuous. The first effect of this fracture and uplift was to produce a continuous ridge; but subsequently the ridge was broken through by diluvial currents, or else the lower points of the intervening strata were worn down, leaving the range of knobs as we now find. Thus Bald mountain and Mount Toby, with several others in the neighborhood, stand in insulated high points, capped with the Calciferous sandstone; while at their bases the Taconic slate appears in an outcrop, varying in thickness from fifty to two hundred feet. But the Calciferous sandstone is not confined to the line in the immediate borders of the valley of the Hudson: it is found in patches twenty miles east, reposing as at the west upon the slates; probably, however, upon the magnesian slates.

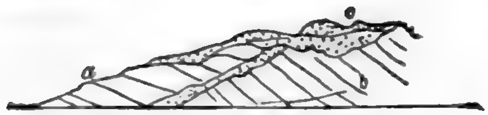
From these few remarks upon this rock, its position and relations will be understood. It is the lowest member of the New-York system, as well as the most easterly; and occupying an exceedingly long range, it is not surprising that its lithological character should be found diverse and continually changing.

I have now exhibited the actual relations of one of the Taconic rocks to the New-York system; that member which on all hands has been considered as the nearest related to the Hudson river shales and sandstones, or the one which approaches the nearest in lithological structure and condition to these rocks.

Having demonstrated the relations of the most westerly mass, and having shown that it is not only unconformable to the New-York rocks, but inferior to them, I proceed to speak of the relations of the most easterly members of the Taconic with the Primary system, for the purpose of showing that the Taconic system is the newer of the two, or that it holds an intermediate position between the Primary schists and the New-York system.

At several localities which I have often examined in Vermont and Massachusetts, the most easterly rock is the Brown sandstone, or Granular quartz. A fine exposure exists at Sunderland (Vermont), nearly east of Salem in Washington county (New-York); or rather of Miller's falls, on the Hudson river. The quartz succeeds a magnesian slate, with which it is conformable; and on being traced to the primary schists, is found to repose upon them unconformably, the former ranging N. 20° E. and dipping at an angle not exceeding 10°, while the primary schists have a much steeper dip to the east. The precise line or plane of junction is concealed by drift, but I was able to observe it within a few yards. Near the junction, the slaty quartz is charged with crystals of schorl and octahedral iron. There are also beds of what may be termed *porphyritic quartz*, since they contain crystals of felspar. A portion of the lowest mass, however, is a breccia, as in many other important localities, of which I shall have occasion to speak hereafter. The quartz, as is frequently the case, is interlaminated with a siliceous slate, by which its stratification is very clearly shown, giving us the means of distinguishing the planes of deposition from the very strong natural joints and those of cleavage.

Fig. 5.



a. Brown sandstone or granular quartz; b. Gneiss with beds of granite, in which quartz predominates; c. Thick beds of drift.

The section in the margin exhibits the connection of the quartz and primary schists, with which, however, there are beds of granite containing a peculiar blue quartz, that enters also into the composition of the breccia already referred to; and I may add that I observed this at Adams (Massachusetts), nearly forty miles further south.

I have now stated the facts in regard to the junction of the Taconic system, first, on the west with the New-York or Silurian system; and secondly, on the east with the Primary schists, with which it is also unconformable. From the preceding account, it is not to be doubted but that there is a system of rocks lying, as has been heretofore maintained, between Hoosic mountain range and the Hudson river, of an age posterior to the gneiss and mica slate, and anterior to the New-York system. It consists, throughout all its beds, of sedimentary matter generally in a state of fine division. These beds are conformable to each other, and arranged in uninterrupted succession, although their lithological characters are very diverse.

These facts, therefore, go to show the unity of the rocks which compose the Taconic system; being deposited during a greatly extended period, which will be shown to have abounded in part in organic bodies, whose forms were as remarkable as any in the animal kingdom.

From considerations which have been adduced in this section, the doctrine of metamorphism is of no consequence. We may admit the fact, without involving the question of age, either in one or both systems: each may have undergone great changes in mechanical texture, without embarrassing our conclusions, even though two limestones, slates or sandstones become by those changes identical in lithological features or composition.

I have already stated that the Taconic system lies between the Hoosic mountain range on the east, and Hudson river on the west: I may now add that it embraces a belt of country at least forty miles wide. This statement is confirmed by my researches since the Report on the Second District was published, its extent being increased by an extension of the Taconic slate beyond those limits which I had then fixed upon. In this ancient system, contrary to what would be expected, perhaps, we find as few disturbances as during any other subsequent periods; that is, in the belt of country between the Hudson at Albany and the Hoosic mountain, no remarkable ones seem to have occurred, except that by which the rocks have been thrown into an inclined position: there are no intrusions of igneous rocks, as dykes, beds of granite, etc.; though when we trace the system south, disturbances are quite common; but even in the midst of them, I may say that the metamorphisms are no greater than in many rocks of a much later date. So that the effects of intruded igneous rocks are not always strongly manifested; and, in fact, in New-York, they are scarcely worthy of attention, unless indeed for the very point stated, the extremely slight change that appears just at the junction of the two rocks, and then the alteration extends only a few inches in depth. For this reason, the best field for studying the rocks of this period is the belt here referred to, embracing the whole country from the Hudson river to the Green mountains. It will be seen hereafter that in Maine we are encumbered with igneous injections, as trap dykes, and perhaps with granitic eruptions; yet even in Maine the Taconic slate seems to be but little affected as a whole by intruded masses, the most disturbed portions being among the lower members of the Taconic system.

II. INDIVIDUAL MEMBERS OF THE TACONIC SYSTEM IN NEW-YORK, MASSACHUSETTS AND VERMONT.

§ 1. Lithological characters and succession.

The researches and observations hitherto made on the rocks of this system, have not yet elucidated their nature so far as to enable us to determine the best mode of treating them. There is no doubt as to their succession; but there are some points of inquiry peculiar to the province of geology, such as whether certain individual masses are to be regarded as subordinate beds or independent rocks, upon which some diversity of opinion may very well exist. On this question, two different views might be adopted and maintained without doing violence to established principles. In the first place, the whole series may be considered as an immense deposite of slate, in which are many subordinate beds of different materials, as limestone, chert or hornstone, breccia, sandstone, etc.; or, in the second place, those individual masses may be treated as independent rocks, though it will still remain true that some of these masses rest upon, and are succeeded by, a kind of slate whose characters are identical. I shall, however, take the latter view, so far at least as the more important masses are concerned, although there are no very substantial reasons for the adoption of this course. Taking one broad view of the whole system, it may be described as consisting of fine and coarse slates, with subordinate beds of chert, fine and coarse limestone, and grey, brown and white sandstone. These admit, however, of more minute divisions than I have here stated, as will be seen in the sequel. But it is necessary, in the first place, to form some conception of the original position of the masses. Their present position is an inverted one; that is, those rocks which are really the inferior, and of course the older, are now the superior, and apparently the older; and we have, therefore, to reconcile this seeming incongruity. Sedimentary rocks are always deposited in a soft movable state, and usually remain in a horizontal position until consolidated. These rocks, however, are now always inclined, their prevailing inclination or dip being to the southeast, and it is towards this direction that the older rocks are found; the consequence is that the newer rocks, or those towards the west, dip beneath the older, or might even pass beneath them, provided they were prolonged far enough in this direction. To escape from this difficulty, we may suppose the masses to have succeeded each other as in the annexed diagram, and the taconic slate, with its subordinate beds, to have been deposited during a slow upward movement of the primary schists and older taconic rocks, which of course would change the bed of the ocean in which these deposits were going on or accumulating; or, we may suppose that early denudations have removed extensive portions of the upper beds.

Fig. 6.

A. Gneiss. 1. Granular quartz, or Brown sandstone. 2. Stockbridge limestone. 3. Magnesian slate. 4. Sparry limestone. 5. Roofing slate. 6. Coarse brecciated bed. 7. Taconic slate. 8. Black slate.

As far as I am informed, there is no objection to the view here presented of these rocks, namely, that of regarding them to have been originally in this position; the oldest member, the brown sandstone, reposing upon the primary rocks A, and each mass to have succeeded as in the diagram, and terminating with a black slate (No. 8), which may never have extended far east. I present this view as probable, and have been led to adopt it from the consideration that the Taconic and Black slates are newer rocks than the Magnesian slate and Stockbridge limestone: they contain fossils, which are wanting in the other members of the series; and though it may be urged that these rocks are so far changed by a variety of causes as to have produced the obliteration of their fossils if any ever existed in them, still when we recollect that fossils are found in many crystalline rocks, and that many layers of considerable thickness are but little changed, I am disposed to assume that the rocks in question never contained fossils. The Grey sandstone, the oldest member, so far as metamorphism is concerned, may as well retain and exhibit casts or marks of organic bodies, as the equally hard siliceous rock, the Potsdam sandstone, at the base of the New-York system. To assist us in maintaining these views, we may suppose the superior members to have been removed by abrasion, and thus limited in an easterly direction; and besides this, as the Taconic system is comparatively narrow, we have reason for assuming the ground that the deposition was but scantily extended east and west, and that the whole system was formed in a deep trough.

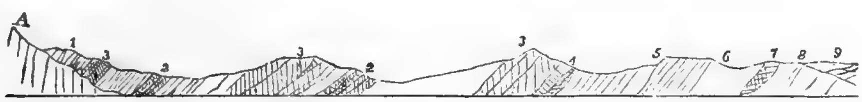
If now we suppose these beds subjected to upheaving forces which we know have existed in all geological periods, they may be forced into an inclined position, and this position may be that general inclination which at present prevails. This position may have been produced by successive uplifts, by which the strata were broken, or their continuity destroyed, and their fractured surfaces raised to an inclination more or less steep according to the amount and duration of the force applied.

Those who wish to pursue the subject of physical change in the belt of country through which the taconic rocks pass, will do well to study the article upon this subject by Profs. W. H. and H. D. ROGERS, in the *Transactions of the Association of Geologists and Natu-*

ralists. It is not my purpose here, however, to pursue the theory of these changes. I regard the dips as having been produced by simple uplifts of the strata; not indeed that they have not been subjected to lateral pressure, by which curvatures were produced in many instances. But admitting the Rogerian theory as it regards foldings and southeasterly dips, and giving it all the stretch of faith which confidence in sound geological principles will admit, still that part of it which connects the Hudson river shales with the Taconic slates in prolonged arches must necessarily fall to the ground.

The position and order of the Taconic rocks I have exhibited in the section Fig. 7. It shows the regular parallel southeasterly dip, and the principal beds together with the succession. From this the reader or student will understand what was adverted to by the terms *inverted strata.* Thus the numbers 5, 6, 7 and 8 refer to the Taconic slate in its subordinate beds, which, as they dip in the diagram, would pass necessarily beneath the rocks situated towards A.

Fig. 7.



A. Primary schists. 1. Granular quartz, or brown and white sandstone. 2, 2. Stockbridge limestone. 3, 3. Magnesian slate. 4. Sparry limestone. 5. Taconic slate. 6. Roofing slate. 7. Rough coarse siliceous beds. 8. Flinty slate. 9. Hudson river shales.

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§ 2. Black slate.

Reasons why this rock is separated from the Taconic slate. First discovery of Crustaceans in this mass. Characters as a rock obscure. Its fossils.

I shall describe the rocks in the descending order; and by so doing, I commence with a mass, of which there is some doubt whether it ought to be considered a distinct rock, or merely the upper portion of the Taconic slate; still I am disposed to regard it now as a separate and distinct rock, forming, so far as examinations have been made, the highest member of the Taconic system. The circumstances which have led to the separation of this from the rock referred to, are of an interesting character; interesting particularly as being connected with the discovery of crustaceans where they were least expected. While examining the strata near Bald mountain, during the early part of September of the present year, my attention was arrested by the discovery of the fossil figured in Plate II. fig. 3, which resembles very closely an annelide of the scolopendrian family; but the specimen is imperfect, and hence its true character cannot be determined with certainty. This discovery led to farther search for additional specimens, but no other fragment has yet been found; although in the course of different searches, two distinct species of trilobites were found by my friend Dr. Fitch, and fragments of others too imperfect to describe.

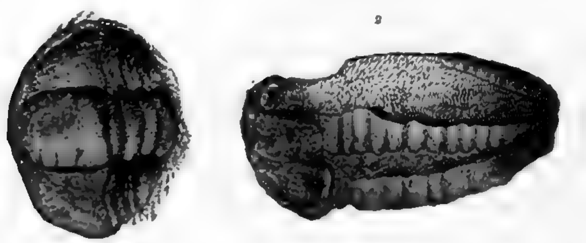
This slate is black, and each layer is often slightly glazed by a film of carbonaceous matter. Black calcareous layers appear in the slate only a short distance from the locality of the fossils, but diligent search there has not been rewarded by the acquisition of organic bodies of any kind. The laminæ, which are quite thin, often exhibit intervening spaces of disintegrating red coarser and more friable particles than those composing the slate, in which we sometimes observe traces of organic matter, too obscure, however, to enable us to form an opinion of its nature.

This mass has no essential character by which it can be distinguished from other slates, though the color may serve to remove it perhaps from the greenish taconic slate which appears but a short distance to the east. Assuming that its fossils are distinct from the rocks of this and the other systems, and provided they were as numerous as those of most fossiliferous rocks, there would be no difficulty in recognizing it. As the matter now stands, we have only three specimens of trilobites, and a fragment of something which appears to be an annelide, but may prove to be a trilobite that shall form a connecting link between the Crustaceans and Annelides.

In consequence of the uncertainty in regard to the light in which this mass ought to be viewed, I dismiss the further consideration of it for the present. The character of the trilobites may be seen in the annexed figures.

Fig. 8.

1 2

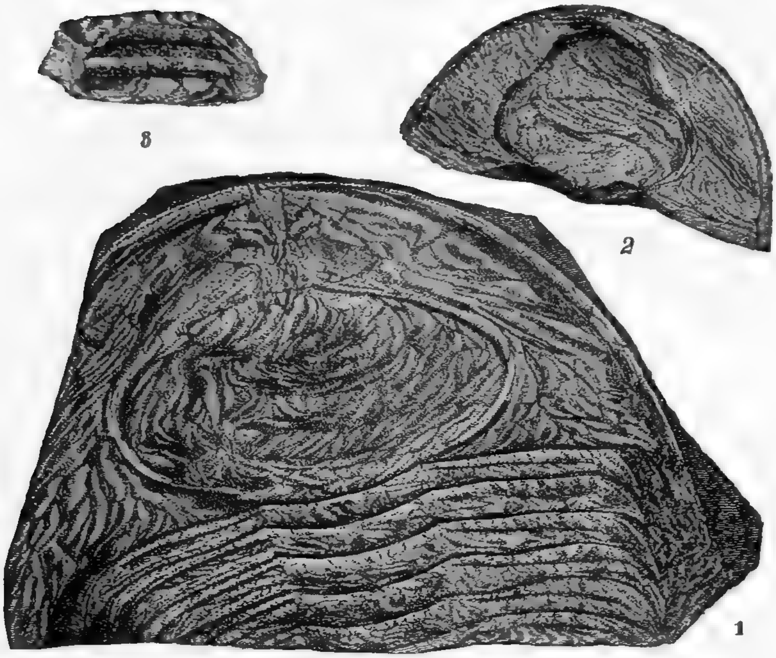


Atops trilineatus.

No. 1, is the head of a trilobite, which seems to belong to an intermediate genus between *Calymene* and *Triarthrus*. The head and part of the body are well preserved in one specimen; but the other (No. 2), is unfortunately badly worn. The latter I at first considered the same species as that represented by No. 1; but on further examination, I have little doubt that they are distinct. The ribs, of which I can easily count fifteen from the buckler to the posterior extremity of the specimen, are drawn too coarsely in the figure. The tail is acute, but not prolonged into a spine: there are no markings upon the buckler. The specimen, however, is too imperfect for a name, and would not have been noticed at all but from a wish to illustrate the rock as far as possible by its organic bodies.

No. 1, I have named *Atops trilineatus*. The absence of eyes, however, is not a distinctive mark: the three species are blind. The *Atops* is evidently allied to the *Triarthrus beckii*, so abundant in the Utica slate; the lines in this, however, are direct or transverse to the middle lobe: there is an additional pair in the *Atops*.

Fig. 9.



Elliptocephala asaphoides.

No. 1, is a large individual, much flattened by pressure: the natural joints of the slate pass through the specimen. The tail and a portion of the body are wanting. I have named this *Elliptocephala asaphoides.* The ellipse upon the buckler appears to be a characteristic marking, while the ribs and middle lobe resemble very strongly the same parts of the *Asaphus tyrannus.* In its perfect form, the ellipse seems to belong to the old and perfect individual.

No. 2, is the head of a small individual of the same species. The ellipse in this individual has an anterior segment not to be seen in No. 1, which I suppose may be obliterated by age.

No. 3, is a fragment of a trilobite probably, but the ribs bear a different character from those we generally meet with.

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§ 3. Taconic slate, with its subordinate beds.

Characters of the Taconic slate. Reasons for the opinion that the coarser beds are not metamorphic. Natural joints. Enumeration of the principal beds; their strike. Reasons for making the Hoosic roofing slates subordinate to the Taconic slate. Discovery of fossils: Fucoides and Nereites. Supposed tube of a Nereites in the coarse slates of Brunswick in Rensselaer county, New-York.

It may be described as an even-bedded aluminous slate, varying from the finest possible grit to one that is coarse and rather uneven-bedded, and passing into a rock having many of the characters of a sandstone. The fineness appears not to depend upon its distance from the western edge of the formation, or on its nearness to the present primary schists on the east; since the mass 7 (Fig. 7, page 19) is a coarse sandstone in the midst of fine argillaceous slate. The latter is even-grained, and finer in texture; a fact which goes to prove that the change is not due to metamorphism, but to the character of the materials from which it is formed. The color of these slates is mostly a pea-green, but they frequently weather to a paler hue, and sometimes appear bleached or of a dirty grey upon the outside. The coarser slates are always of a dirty greyish green, and though thin-bedded, never split with an even surface. The fine-grained, on the contrary, are of brighter colors, and split with a tolerably even surface, and hence have been used very extensively for flags. Other portions of the rock are nearly black, passing into blue. This dark color is usually due to the presence of sulphuret of iron, which, decomposing, imparts to the slate the black tinge peculiar to one form of sulphur when liberated from its combination with iron. This fact has led some geologists into error, by supposing that the dark color is due to the presence of graphite; and as this variety is often in proximity to the limestones or limestone shales, it has led to the adoption of the opinion that by heat the limestone has been made to yield the carbon necessary to form the graphite; and what has served to confirm the fallacy, is the fact that the slate is often finely glazed by strong pressure, when raised from a horizontal to its present inclined position.

The surface of this slate is often beautifully rippled, like many of the finer sandstones in the New-York system, and still it retains the fine earthy texture of a sedimentary rock. The principal change which it has suffered, is the development of numerous natural joints, by which the laminæ separate into rhombic prisms with angles varying but little from 60° and 120°. In very many places, it assumes that peculiar silvery greenish grey common to the talcose schists. I have not observed any change in its state or condition, which can be termed with propriety *metamorphic*. It never loses its earthy texture, or never has acquired characters which may not be ascribed simply to pressure, and the common molecular attraction which all kinds of matter are subject to. The simple drying of the rock has produced shrinkage cracks, which have been filled with calcareous spar or fibrous limestone; and wherever, by crushing and fracture, empty spaces were made, they too have been filled with carbonate of lime or quartz, a result common to all rocks.

The subordinate beds are,

1. Coarse harsh sandstone with angular grains, imbued more or less with chloritic matter, and traversed very thickly with seams of quartz, by which the rock is divided or divisible into all kinds of angular masses: their planes thickly set with imperfect crystals of quartz.
2. Beds of grey sandstone with seams of quartz, but not very prominent.
3. Green and black flinty slate, which breaks with a large conchoidal fracture.
4. Blue compact limestone beds, and limestone breccia generally filled with sparry seams. Portions seem to be a regenerated rock from fragments of a pre-existing mass. This is, however, quite limited in extent.
5. Roofing slate, of fine even texture and of a good quality.
6. Red and chocolate-colored slates, usually fine-grained, but sometimes coarse and micaceous.
7. Beds of grey siliceous limestone, whose characters approach nearly to the calciferous sandrock. It is traversed also by seams of quartz and calcareous spar.

I deem it unnecessary to describe these beds more minutely, except to remark generally that their thickness varies from a few feet to sixty; the coarse and finer sandstones are about sixty feet in their greatest development, and the siliceous sandstone about thirty. The beds of roofing slate may or may not be over sixty feet thick. The blue sparry and brecciated limestone is about twenty or twenty-five feet thick.

All the above masses are strictly beds, lying parallel to the beds of slate whose strike is N. 10° E. by compass. The presence of these beds, their relations to each other, and the great mass which embraces them, are facts of sufficient importance and character to lead to the separation of this slate from the shales of the Hudson river. To be satisfied of this, let the inquirer traverse the rock from west to east: he will usually find, first, a fine greenish slate, passing into a coarse siliceous slate, with one or two beds of the coarse sandstone with angular fragments; passing on farther, he will meet with a bed of flinty slate, associated perhaps with a few sparry layers of limestone; then a bed of more perfect sandstone; then, one of liver-colored slates; and still farther to the east, and near the great mass of the sparry limestone, he will find the roofing slate. In following this direction, however, he will, in the space of fifteen or twenty miles, pass several times over the same beds, which are brought up by many successive uplifts.

The roofing slate had been heretofore classed among the Hudson river rocks or the Loraine shales, but later observations have proved in the most satisfactory manner that it is a part of the Taconic slate. I was led into this error myself by the discovery of fossils, which had much the appearance of the *graptolites* of the Utica slate, but which I am now satisfied are marine vegetables. Those geologists who are well acquainted with the different beds of the Hudson river series, will at once see that they do not, as a whole, agree with or correspond to those of the Taconic slate; and though Prof. Rogers remarks in his address, that my sections in general correspond with his own, requiring merely the restoration of the great curves in order to make the correspondence perfect, *except* in the want of conformity of some of the beds; it may be replied, that although the Hudson river shales and Taconic slates may be connected by supplying curves, it is only an accidental coincidence, the fact being perfectly clear that no real similarity can exist in two systems, one of which is anterior to the other. And I may very properly remark, that it furnishes a lesson well worthy of remembrance even to so learned and accomplished a geologist as my friend Prof. Rogers, not to place too much reliance upon the imagination; for certainly it is plain that an inferior system can not be connected with a superior, although a certain similarity may exist in regard to order; and though two sections, one of which is from the former and the other from the latter, may have coincident masses, still from this alone without other kinds of proof, they ought not to be considered identical.

FOSSILS PECULIAR TO THE TACONIC SLATE.

At the time of the publication of my Report for the Second or Northern Geological District, I was not satisfied that the rock now under consideration contained fossils. It is true that obscure traces of fucoids had been discovered in beds of slate in Cambridge, Washington county, and those of a more perfect character were known in the roofing slate; yet the strong prejudice which then existed to the plan of separating these slates from the Hudson river series, led me to retain them in the New-York system, considering the roofing slate of Hoosic in particular as an outlier of this series. However, no doubt now exists as it regards the place these beds occupy: a full and careful examination has established the fact that they are varieties of Taconic slate, and appear only as subordinate beds. We are not now so limited in organic bodies as at the time referred to. I have since discovered at least three genera of the red-blooded worms in the slates of Washington county, in addition to the trilobites of the black slate; and I had an opportunity to inspect five or six species of *Nereites*, and two species of *Myrianites*, during my visit this season to Waterville, Maine. I now feel confident that we have much additional evidence in these peculiar fossils, not only of the propriety of separating this rock from the shales of Hudson river, but of the independence of the Taconic system; and how strong this evidence might be considered if it stood alone, and without the proof from other sources of the inferiority of its position, I am not prepared to say; but, without question, the fact itself is one of the most interesting in geology. For how remarkable it is that those curious organic bodies of the nereitoid family should characterize a group of rocks; and certainly it is not too much to say this, when we find them in the same rock in New-York, Maine, and Wales in Great Britain, three places so distant from each other! It is true that the number of species at present known is comparatively small, still this ought not to be considered a strong objection, inasmuch as but little search has yet been made; and besides, their peculiar forms, and the mode in which they are preserved, are such as to leave them obscure and very liable to be overlooked.

As the fossils here referred to appear to be new, I have been obliged to propose new genera for their reception. The inspection of the figures, I have little doubt, will satisfy most geologists and naturalists that they belong to the family of *Nereites*, closely allied to the Llampator fossils figured by Mr. Murchison and determined by Mr. M'Leay. At any rate, they do not appear so aberrant in their types as to exclude them from this family.

Plate XIV. fig. 1. I have called *Nemapodia tenuissima*.* It is found in the fine green taconic slate of Salem, Washington county, New-York. It is quite abundant.

Fig. 2. *Gordia marina*. It resembles the *Gordius*, a freshwater worm, usually called *Hair-worm*. No joints or swellings can be discovered in the fossil. It is in the fine flagging stone of Mr. M'Arthur, in Jackson, Washington county.

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* *Nema*, a thread; *pous*, a foot.

Fig. 3. Is an imperfect fossil, which I have suffered to remain for the present without a name. It appears more in the character of a land than of a marine animal. It belongs probably to the Annelides, but it is unsafe to speak with much confidence on the character of imperfect specimens. It is associated with the trilobites of the black slate. It is remarkable that this locality has not furnished two specimens alike, or of the same genus or species. Several days' works by experienced observers have been spent here, and a great quantity of slate carefully examined: the success, however, has been quite disproportionate to the labor bestowed.

Plate XV. exhibits three species of *Nereites.*

Fig. 3. *Nereites jacksoni,* a name conferred from respect to my esteemed friend Dr. C. T. Jackson. It is the largest species yet discovered.

Fig. 2. *N. loomisii,* is named in honor of my friend Prof. Loomis, of Waterville College, Maine, to whom I am greatly indebted for specimens and assistance while engaged in the examination of the rocks of that State.

Fig. 1. *N. pugnus,* a very remarkable fossil, as will appear from the additional figure given of its termination on Plate XVI.

Plate XVI. fig. 6. *Nereites lanceolata,* is a beautiful species, not very abundant at Waterville, but is finely preserved.

Fig. 5. *Myrianites sillimani,* closely resembles the *murchisoni,* but is larger and more distinctly knotted. I have named it with reference to the editor of the American Journal of Science.

Fig. 4. *N. pugnus.* I am disposed to consider this as the caudal extremity, rather than the head. It is the only one which has exhibited distinctly a termination.

Fig. 3. *N. gracilis.* Only one specimen has been discovered of this species.

Fig. 2. *N. deweyi,* is a very beautiful nereite, which I have named after my distinguished friend Prof. Dewey of Rochester, who in his early geological investigations gave much time to the lower taconic rocks.

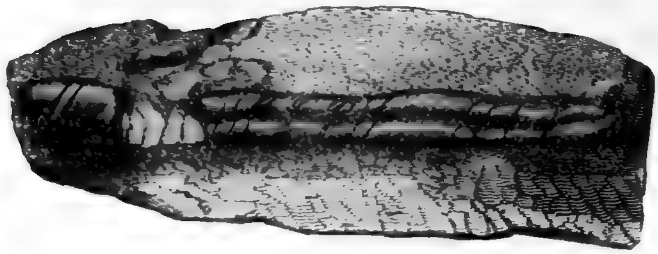
Fig. 1. *Myrianites murchisoni,* named after the celebrated author of the Silurian system.

Plate XVII. I have figured two fucoids, which are associated with the fossils of this slate in Washington county, *Fucoides flexuosa* and *rigida.* The first is a long flexuose leaf: it sometimes appears on the flagging stone of M'Arthur's quarry, two feet in length. The other is much smaller, and appears rather stiff and rigid. Fragments of both species are common in the slate, sometimes quite obscure, especially when weathered, in which case they lose their black color.

Such are the fossils of the Taconic slate; few, indeed, but of an exceedingly interesting character. We can hardly expect, however, that the species will be greatly multiplied, or that the localities will be numerous.

In addition to the fossils of this slate, I have one more to add, of a singular character. It appears to be a tube, perhaps the earthy case of an annelide. Of its organic nature there is no doubt; and that it was a *tube,* there is not much doubt, as it appears to be partly crushed. It is represented in fig. 10.

Fig. 10.



The slate in which this specimen was found is rather coarse, and somewhat unlike the fine green taconic slate. It is not easily split into laminæ, and hence it will be difficult to obtain the fossils it may possibly contain. It was found in Brunswick, Rensselaer county, by my friend Dr. SKILTON of Troy.

That the above fossil was the tube of an annelide, is of course suggested by the circumstance that animals of this class are found in this rock: the idea is in keeping with this fact, and probably would not have been thought of independently. It is evident, however, that the annelides yet discovered in the Taconic rocks were naked, or did not construct tubes for their habitations; so that it is not supposed that this relict was the tube of one of the species which I have figured and described.

Should no farther discoveries in fossils be made, the Taconic system will present a very singular and remarkable condition: the animal kingdom being represented for a long period by a single fragment, and that fragment belonging to one of its obscurest families, yet not the lowest in the scale of organization; but the most striking peculiarities consist in the remarkable forms here preserved, and the absence of all others which might serve to connect them with the known parts of the series. The *Nereites* and congeners standing, as it were by themselves, the sole representatives of one of the kingdoms of nature! Subsequently each geological period or era had many forms, typical of many divisions of the animal kingdom. But here, the entire absence of those forms which become so abundant at the very commencement of the succeeding system, is, to say the least, extremely interesting. However, so strange an anomaly is not to be admitted at once; although for many years these rocks have been diligently examined, without furnishing a single mollusk.

I would here remark, that in consequence of the similarity of the taconic slates and some of the rocks of the Champlain group, fossils have been occasionally presented in their matrix, when it was doubtful to which system they belonged. In these cases I have invariably visited the spot, for the purpose of determining the exact position the fossil occupied; and, in all cases where they were testacea, they were found in the New-York system.

The members subordinate to the Taconic slate have been enumerated. The order in which they are disposed is exhibited in the plate of sections. In three of them only have fossils been found. The coarse slaty sandstone of a greenish color, which is the first mass met with going from west to east, is the mass in which the fossil represented fig. 10 was found.

Not far distant is a bed of sparry limestone, more slaty than the rock described under that name. This is only about fifteen feet thick. The question comes up, whether this mass may not be the thin western edge of the true sparry limestone, the rock next described? I know of no facts which favor this view, except the very equivocal one, lithological character.

Another mass whose characters are quite remarkable, is a breccia lying at the western base of the Taconic range. It is developed largely; more so, I believe, in East Sandlake, and about twelve miles east of the Hudson at Albany. It forms a high broken rough range of hills which terminate just south of the macadam road in Pittstown, sixteen miles west of Troy. There are no rounded pebbles in the rock, but angular ones nearly half an inch in diameter. Much of the rock resembles a porphyry; it is thick-bedded, and interlaminated with fine green slate. The thickness of the mass remains undetermined: it is probably two hundred feet. Some portions of this mass have a very strong resemblance to the thick-bedded sandstone of the Champlain group.

ROOFING SLATE.

This is one of the most easterly of the subordinate masses. It is a fine bluish black slate, even-bedded, and well adapted for roofing. Some of the layers are slightly pyritous. Geologically it is interesting, from the great abundance of marine vegetables. Plate XVII. fig. 1, is copied from a lamina of slate from the Hoosic quarry, about twenty miles east of Troy. This quarry has been wrought over twenty years, and no other fossil has been discovered. The absence of the mollusca here, too, is well worthy of notice. It is possible that two species of fossil vegetables may exist in this slate; one with a narrow frond, and the other with a wide one.

RANGE AND EXTENT OF THE BLACK AND TACONIC SLATES.

The black slate is not as well exposed as the taconic; there is, therefore, some uncertainty in regard to it. It is the rock adjacent to the Champlain and Hudson valleys, and more frequently that which we observe immediately beneath the calciferous sandrock, or cropping out from beneath it. What we see of it, is frequently in a crushed condition, and bounding the taconic slate on the west in New-York and Vermont. I have not recognized it about Albany or Troy. Greenwich in Washington county is the most southern point at which I have observed it. It extends north as far as St. Albans in Vermont. I speak of those points which I have inspected. On St. Albans bay, it is traversed by satin spar. It is also calcareous here, as well as at numerous other points upon Lake Champlain. It crops out from beneath the Calciferous sandstone at Sharpshins near Burlington. I am unable to form an estimate of its thickness.

The Taconic slate, with its subordinate beds, occupies almost the whole of Columbia, Rensselaer and Washington counties. It extends to the base of the Taconic range of mountains, which divides New-York from Massachusetts and Vermont. Lying in its usual inclined position, if no repetitions of the same mass occur, it is of immense thickness. For example, from Lansingburgh to the Sparry limestone in the eastern part of Hoosic, near the western bounds of Bennington in Vermont, it is at least twenty miles in a direct line. Its dip varies from 45° to 70°. But admitting that the same mass reappears, it will still be found immensely thick. I have often examined it two miles perpendicular to its strike, and found no indication of repetitions. I leave it to a future opportunity to make an approximate determination of its thickness, or to others who may take up the subject.

This slate crosses the Hudson above Newburgh, and passes through Orange county into New-Jersey. On the west in this latter county, we find the Hudson river shales with their fossils, by which they may be distinguished from the slate.

Without doubt this immense rock admits of subdivisions; that is, it will probably be found proper to make those masses which I have treated as subordinate, independent rocks, of which perhaps others still will be recognized of sufficient importance to merit the same distinction. In whatever light we may regard these minor points, there is no doubt that the quantity of matter in this slate exceeds that of all the members of the New-York system put together.

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§ 4. Sparry limestone.

Distinctive characters. Origin of the Plumbaginous slate. Rock at the Western Railroad Tunnel: reappears in uplifts. Resemblance to the Calciferous sandstone. Mineral contents. Range and extent.

The name which has been retained for this mass, is acknowledged to be objectionable, as most descriptive names are in geology; for it will apply, and in fact has been applied, to several different rocks. This, however, received its name from the late Prof. Eaton; and as he recognized it as a distinct rock, and I suppose very properly, I have deemed it best to retain it.

This limestone has a bluish ground, through which are innumerable seams of white calcareous spar, which give the rock a remarkably checked appearance. Other rocks are also traversed in this way, but the structure is by no means so striking. The color is sometimes a grey, varying from light to dark. It contains masses of milky as well as grey hyaline quartz, which also traverse it in the form of seams. It weathers unevenly, by which there is formed a rough surface impressed with fissures crossing each other in all directions. It is not a pure limestone, though it is very frequently employed for lime. If this rock should prove sound after it has been penetrated a few feet, it would make a fine and beautiful marble similar in aspect to the so-called "Egyptian marble."

The dip of this rock is conformable to that of the whole system, varying from east to southeast. The strike corresponds also to the other members of the system, which varies but little in any part of its range from N. 10° E. In the State of New-York, the Sparry limestone occupies the belt of country comprising the eastern part of Dutchess, Columbia, Rensselaer and Washington counties, passing about one mile east of Hoosic four-corners; and in its progress north, it strikes the west line of Arlington in Vermont. It forms the eastern boundary of the Taconic slate. It passes through a region of rounded hills, steeper upon their western than upon their eastern sides, but less elevated than the range still farther east, near whose bases the Stockbridge limestone ranges. It is not an easy matter to trace this rock continuously, partly from the great amount of debris which has been deposited upon it and the adjacent masses. In some parts of the range it seems to have been engulphed or pinched out, or lost by some of the disturbances to which the rocks have been subjected. Still it is a very persistent mass, and is never lost in the whole range through New-York but for small distances. This rock is the *Transition limestone* upon the geological map constructed by Prof. Dewey for illustrating the geology of Berkshire county, Massachusetts. The tunnel of the Western Railroad is cut through this rock, the length of which is about five hundred feet. At this place, the junction of the slate and limestone is by intermediate beds of plumbaginous slate, as it is termed, a variety which soils the fingers.

It only requires an examination with the microscope to satisfy any one that the dark colored strata are highly charged with sulphuret of iron in fine crystals, which, on exposure, decompose and form a thin coating of a dark material, the greater portion of which is sulphur, mixed probably with the black oxide of iron. According to this view, there is no important change produced by heat at the line of contact of the rocks, but simply a decomposition of the sulphuret of iron disseminated through the intermediate layers. At the Tunnel, too, as in many other places, the limestone is highly siliceous; and so common is this earth, that but few localities furnish a stone suitable for lime. I have no satisfactory account to give of the origin of the calcareous veins: their presence is constant, though not always equally profuse.

The thick mass which I have had in view, and which ranges through the eastern part of the counties named, is not the only mass of limestone which possesses this character. Proceeding westward from this point to the western bounds of the Taconic slate, thin deposits of a sparry limestone occasionally occur, some of which are twenty feet thick, and others less; the thinnest and most unimportant being farthest towards the western bounds of the slate. The causes, therefore, which concurred in the production of the Sparry limestone, continued to operate with more or less energy, but only at intervals, during the whole period when the slate was being deposited. I do not suppose, however, that all the beds of this character are different beds: some are undoubtedly mere repetitions of the same mass. Other causes also seem to have operated at times, in such a manner as to break up the already consolidated strata, which were subsequently reconsolidated without removal; at least we find angular fragments united by the intervention of calcareous spar.

No fossils have yet been discovered in this rock, though it must be confessed that sufficient examination has not been made for microscopic bivalves. In searching for fossils, it will be necessary to caution against the mistake which might be made in some localities, by confounding the Calciferous sandstone with the Sparry limestone.

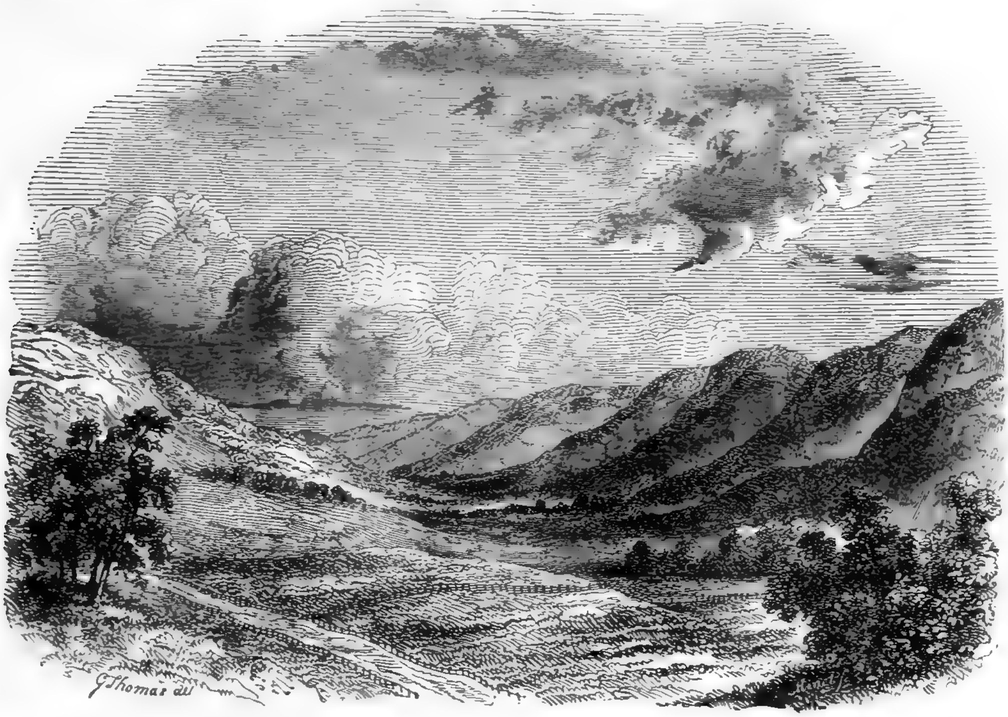
MINERAL CONTENTS.

Sulphurets of lead and zinc. The Sparry limestone is the depository occasionally of thin veins of the sulphurets of lead and zinc. Two localities have been known for many years, namely, Ancram in Dutchess, and Whitecreek in Washington counties. The former is the most important, but has not been profitably worked; the latter is a very insignificant mine, furnishing only small bunches of ore connected together by very thin strings of the same.

RANGE AND EXTENT.

This rock passes not far west of the dividing line between Massachusetts, Vermont and New-York. By townships, we find it passing through Ancram, Hillsdale, Canaan, New-Lebanon, Berlin, Petersburgh, Hoosic, Whitecreek, the west part of Arlington (Vermont), and onwards in the same range north through the eastern townships of Canada East. After passing through the tunnel of the Western Railroad, where it is at least two hundred and fifty feet thick, we pass a succession of uplifts which bring up this rock in low hills: these continue about four miles. It is evident that here we pass over the same mass several times. But as I have already observed, it may not be found at all at many points in the direction of the strike; while at other points it seems to expand widely, as between Canaan and West-Stockbridge. It extends two miles west of the New-York State line, upon the Western Railroad, where it is succeeded by the Taconic slate.

Part of the Taconic Range from Stone Hill.



§ 5. MAGNESIAN SLATE.

Produced in all periods. Different varieties. Characters. Resemblance to slates of the Primary system. Lithological characters do not determine age: Instance the Cumberland coal-field. Milky quartz common in this slate. Absence of steatite, etc. in the Taconic range. Mountain ranges composed of this slate. Extent. Soil and scenery.

The almost endless diversity in rocks familiarly denominated *slate*, occasions much perplexity to the student of geology. It is proper then to say in this place, for his special benefit, that slate has been produced in all the periods of the earth's history, or in all formations; that in all cases the original material must have been a mud highly charged with clay, or alumine; and that its composition varies greatly, from a pure clay or alumine, to a silico-aluminous deposite, or an argillo-calcareous one. These ingredients may exist in the slate in an endless diversity of proportions; and in addition thereto, magnesia enters into the composition of some varieties. These varieties are termed *magnesian slates*, and may be usually known by their unctuous feel. The slate which succeeds the Sparry limestone on the east possesses the latter character, and hence I have denominated it *Magnesian slate*. It is doubtful whether this rock is essentially different from many portions of the Taconic slate; still I believe that it is proper, upon the whole, to separate them, as in their extremes they are quite different rocks.

The color of this slate is usually light grey, with greenish patches. Sometimes it is dark, for the same reason that the preceding slate is so, namely, the presence of a decomposing sulphuret. The broad layers into which the mass often readily splits, have a soft pearly lustre, and a soft unctuous feel.

The magnesian slate, however, is not uniform in its characters. It passes into a rock, which at first view has been taken for mica slate; but generally I believe it is not difficult to see that it is not really the latter rock. This is especially the case in the county of Berkshire, where there are some patches which very strongly resemble the finest varieties of mica slate. I certainly would not quarrel with a geologist, should he insist that some portions of this rock lying towards the Hoosic mountain are really and lithologically *mica slate*. In truth, at present it is a matter of perfect indifference with me. I do not consider, even if it should prove to be this peculiar rock lithologically, that it would affect the question of its age or place in the geological systems, or that it would throw this mass into the class of primary schists; for observation proves that such kinds of slate may be produced in any of the earlier periods, witness the so-called talcose slate in the Old Red sandstone of Cumberland in Rhode-Island. Its presence here shows conclusively that such a slate may be produced when the original materials of a suitable kind are furnished. Much of the ancient and primary aspect of the Rhode-Island and Mansfield beds is due to the character of the surrounding rocks, which have furnished the materials; though I by no means deny the agency of a high subterranean temperature in effecting certain changes. But I am not ready to admit that this is all, and that these peculiar varieties of rock could have been produced independent of their original materials.

MINERAL CONTENTS.

The Magnesian slate is very largely supplied with masses of milky quartz. So abundant indeed is this mineral, that it occurs in boulders over a wide extent of country where the slate is the principal rock. It is not in beds or veins, but it appears in irregular masses or bunches. Thin seams are not of unfrequent occurence. There is often a peculiar association of minerals in the Magnesian slate; thus, the quartz, though frequently pure milk white and opake, contains bunches of chlorite intermixed with the carbonate and oxide of iron and manganese. They usually appear upon the surface, like a disintegrating mass of a dark color, and of a spongy texture. This rock is far less fissile than the Taconic slate, and furnishes only the inferior kinds of flagging. It is less liable to decompose, and hardly furnishes, when decayed, a clayey mass like the preceding slates.

After all, but little diversity of character is found in this rock, whether we examine it on the borders of the Sparry limestone, or along the eastern border of Massachusetts, and ranging side by side with the Hoosic mountain.

The minerals which appear to be peculiar to the talcose slate of the Gneiss system, as steatite, potstone, hornblende, etc., do not appear in this rock in New-York and Massachusetts. Of their actual appearance in this rock in one or two localities, I shall have occasion to speak hereafter. We find, however, needleform schorl, octahedral iron, and sulphuret of iron in unmodified cubes, both in Williamstown (Massachusetts), and Arlington (Vermont).

RANGE AND EXTENT.

In my Report, I have spoken of two ranges of this rock, which I supposed to be two masses, or might be made out as such, one on each side of the Stockbridge limestone. I here speak of the main bed of limestone, for thinner and less important ones exist.

The mountains composed of this rock are the highest in the Taconic ranges, rising from one to three thousand feet. Saddle mountain, between Williamstown and Adams, is twenty-seven hundred feet above the Hoosic, and thirty-four hundred above the level of the sea, or the tide water at Albany. A range of mountains composed of this slate extends along the western border of Massachusetts, and through Vermont. It often rises to the height of fifteen hundred feet. This range is known as the Taconic range, and has furnished the name to the system of rocks I am describing.

From these considerations, it appears that there are two parallel ranges of mountains which are composed principally of this rock. Thus the range at the western base of the Hoosic mountain, in which Saddle mountain is the highest point, is the first. The second is the range four or five miles west: it is inferior in height through its entire extent. The two ranges are connected by lateral spurs; and sometimes, in consequence of their close position, they seem to coalesce, and to obliterate as it were the intervening valleys.

The Magnesian slate is one of the most permanent and extensive members of the Taconic system. It crosses the Hudson about thirty miles above the city of New-York, and passes south through New-Jersey into Pennsylvania, beneath the New Red sandstone, under which rock it disappears near Stony point upon the Hudson river. It ranges north as far as my knowledge extends, having seen specimens of it from the townships in Canada East. It is parallel to the preceding slate, ranging N. 10° – 15° E., with a dip of from fifty to eighty-five degrees.

It is not known to contain veins of the oxides or sulphurets of the metals: it only contains those bodies in disseminated particles. In the regions which have been spoken of, no trap dykes are known to traverse this rock; a fact which is remarkable, when we take into view the great extent of the country over which it is a prominent rock.

The breadth of country over which it prevails is not much less than fifteen miles, leaving out of consideration the Stockbridge limestone and Brown sandstone or Granular quartz. Its absolute thickness cannot be determined with any certainty: it is undoubtedly great, and ranks in this respect with the primary schists. No trace of organic bodies has hitherto been found in this rock.

The relations of this rock are given in Fig. 7 (page 63), and also on Plate XVIII.

This slate disintegrates slowly: it forms a flat gravel, but more tenacious of water by far than siliceous gravel. By itself, or unmixed, it makes a poor soil; but when compounded with the calcareous matter of the Sparry and Stockbridge limestones, it forms an excellent soil suitable for maize.

The hills capped with this slate are all rounded; the sides, however, are quite steep, particularly upon the northwestern slope. The scenery, through a great extent of country north and south, is very uniform, but is occasionally bold in the highest parts of the chain. The most interesting and generally admired view is that of the Hopper and Gray Lock, about five miles southwest of Williams College. The mountains here consist of two ridges: the western or lowest ridge, which is about eighteen hundred feet high, is broken through, or into two parts, quite to the foot of the ridge, nearly west of Graylock. Plate XIII. is a view of Graylock and the western ridge, which has been broken down so as to exhibit the higher and easterly ridge, the summit of which is known as the highest land in New-England. In some parts of this elevated region, rocks are bare for hundreds of feet in elevation, with a steep slope, and may, without much difficulty, be examined from the base to the top; still the summits are thickly clothed with soil, and good pasturage is obtained upon the highest parts of the ridges.

The view at the head of this section illustrates the appearance of the Taconic range generally. It was taken from the south part of Stonehill in Williamstown (Massachusetts), looking south. The hills are composed of slate gravel, and the rocks are usually deeply covered with soil. Most of the hills and ridges of this range abound in chesnut, intermixed with black and white oak: the highest portions of the ridges are clothed with white birch as a second growth. Sugar maple (*Acer saccharinum*) frequently forms by itself large groves. Beech also abounds; and ash, bass, walnut and soft maple are intermixed, and assist in making up the forest. The northern slopes of the higher ridges are usually clothed with black timber, consisting of spruce and hemlock. The slopes of these ranges are beautiful in autumn, when they appear decked in all the gay colors that adorn the windows of a print shop; or arrayed rather in the brilliant robes of a bridal ceremony, than in the sombre habiliments proper to announce the speedy approach of winter as the grave of the year.

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§ 6. Stockbridge limestone.

Origin of its name. Differences in beds. Coloring matter of this limestone when clouded. Presence of sulphuret of iron and silex. Disintegration. Relative position. Its minerals. Range and extent. Doctrine of metamorphism.

This rock is widely and extensively known under the name of *Stockbridge marble.* Most of the white and clouded limestones in market pass under this general name, though they may have been obtained elsewhere. It is proper to remark that the Philadelphia marble consists of the same material, and is obtained from the same range of rock prolonged into Pennsylvania. For a general name, I prefer that of *Stockbridge limestone,*

PLATE XIII.

[illegible]

embracing therein all the limestones, good and bad, in connection with the bed known as marble.

The principal differences in the beds comprised under this general name, are found in the colors and texture of the rock. Of the colors, a small proportion are white and saccharoidal, fine and coarse, clouded and mottled with blue, dark or light, the latter forming the dove-colored marbles. This embraces also the magnesian limestones, or the dolomites; inasmuch as the pure limestones pass into this species by imperceptible gradation. No real difference is known as to position: both mineralogical species occupy the same range. The coloring matter of the limestone is a substance derived from the slate, and which seems to be only the matter of the slate in a state of fine division. These colors are not known to change like those derived from some of the metallic oxides. The stains and tarnishes which appear on some of the wrought marbles, are the effects of decomposed sulphuret of iron, the presence of which is doubly injurious, by hindering the polish of the material, and subsequently destroying the beauty of its color. The beds adjacent to the slate are impure from the presence of this matter, which then appears only as a dark dirty shaly limestone; but many of the layers are largely contaminated with silex and masses of quartz, which render the stone useless except for fences and the coarser materials of construction.

The siliceous limestones disintegrate rapidly even below the surface. Even the underground ledges divide and separate into stones, which, when first exposed to the light and air, are covered with a fine sandy coat. Probably the presence of magnesia facilitates the disintegrating process, and assists materially the conversion of the rock into soil.

This limestone is embraced in the Magnesian slate, and it is not possible to discover any difference of the slate on either side of it: it is in fact one rock. The bed of limestone commences with a few alternations of slate and impure limestone, till finally the beds of the latter predominate. Their thickness is moderate at first, but increases towards the central or middle part of the mass: they there become two feet thick. They are often interlaminated with talcose matter, usually in distinct scales, and arranged so as to mark the direction of the strata. Sometimes there is a mere sprinkling of it in scales the tenth of an inch in diameter.

The remarks which have now been made, apply to the principal deposit or main bed of limestone traversing the Hoosic and Housatonic valleys in part, and thence passing south and terminating on the Hudson river at Singsing in New-York. A few thinner beds run parallel with the main one, resembling in this respect the relations of the Sparry limestone. It appears from these considerations that at one period abundance of calcareous matter was furnished from some source, probably the primary limestones of the Gneiss system, but which, from some topographical change, ceased at another period to be furnished, though at distant intervals it was supplied by a recurrence of the same causes. The smaller beds of limestone run parallel with the larger, and all in the general strike of the system.

MINERAL CONTENTS.

The mineral beds or veins in the Stockbridge limestone are few, and of little importance. Copper and iron pyrites, sulphuret of lead in small lumps and particles, and silver in some form and condition, have been long known at Singsing. The vein containing the silver has not been opened since the war of Independence.

This rock, however, contains a large amount of oxide of iron, disseminated principally at the junction of the limestone beds and slate, although the original form seems to have been that of a sulphuret. From these beds the hematitic iron appears to be derived. They are always tender and disintegrate rapidly, are magnesian, and frequently contain manganese in addition to the iron. Quartz in fine crystals frequently occurs either in bunches or imperfect seams, associated both with albite in twin crystals, and pearl spar.

RANGE AND EXTENT.

The Stockbridge limestone, in New-York, Massachusetts and Vermont, trends N. 10° E. Commencing at Singsing, it runs a northerly course through Westchester, Dutchess and Columbia counties, bordering upon and extending into Connecticut. It passes up the valley of the Housatonic, and thence over the dividing ridge into the upper valleys of the Hoosic onwards into Vermont, through Shaftsbury, Arlington, and thus on towards Lake Memphremagog. I am not, however, well informed as to its entire range north. From personal inspection, I found it well developed in Arlington. At Johnson, and farther north at Lake Memphremagog, are beds of granular limestone, destitute of graphite, which I suppose may be prolongations of the Stockbridge limestone; still, my examinations have been too hasty and too imperfect among those mountain ranges, to form an opinion satisfactory to myself.

The thickness of the greatest mass of Stockbridge limestone in the Berkshire valleys, is about five hundred feet. Of this thick mass, but a very small belt is suitable for marble. The absolute white layers are always comparatively thin; but by sawing the strata through the white bands, it is easy to obtain white facings for monuments and other ornamental purposes. Where the white masses predominate, silex is a very common element in the rock, and therefore it frequently spoils it for the uses to which it might otherwise be applied.

At Williamstown, Massachusetts, the Stockbridge limestone occupies all the base of the first high ridge represented on Plate XIII. Thick beds of drift conceal the rock at the first terrace above the valley; but above this, the rock appears, and is well exposed up to its junction with the slate that crowns all the mountains which appear in this illustration. Along the base of this mountain is a fracture whose direction is nearly north and south, and the limestone forming the valley was severed from that of the mountain side by an uplifting force.

OBSERVATIONS ON METAMORPHISM.

A few remarks seem to be called for in this place, in answer to the views of Prof. Rogers and others, who maintain the doctrine that the Stockbridge limestone is a metamorphic rock. I will first select a passage from his late Address before the Association of American Geologists and Naturalists. I would premise, however, that I protest against opinions on important geological points, unless they are based upon some fact, and those facts are such that others can see and draw their inferences from localities which they can examine. The passage referred to reads thus:

" The granular Berkshire marble (Stockbridge limestone) was identified with the blue " limestone of the Hudson valley, but metamorphosed by heat; and the associated mica- " ceous schists were referred, in the language of the communication, to the slates of the " lowest formation of the Appalachian system, while the semivitrified quartz of the western " part of the Hoosic mountain was stated to be nothing else than white sandstone (Potsdam " sandstone) of the same series slightly altered."*

It would appear from this passage, to one unacquainted with facts, that something had been shown or demonstrated, because the words used, "*identified with*," require the highest kind of proof, and imply the nearest relationship; but after all, nothing has appeared on the whole face of the subject, but opinion, mere opinion.

I have introduced this passage from the Address, not for the purpose of finding fault, but for showing what Prof. Rogers's views really are, that there may be no misunderstanding in relation to this interesting subject; and I cannot but hope that my friend, in his communications in future, will avoid the words "identified with," when he speaks of the Berkshire marble.

One of my arguments for the non-identity of the marbles and slates, etc. of the Taconic system, was drawn from the order of succession of the members of the system, an order essentially different from that of the Champlain or lower division of the New-York series. This argument I still maintain, and challenge any geologist to reconcile the order of one system with the other. While Prof. R. admits that this is true apparently, I maintain that it is really and actually true; and to satisfy an impartial mind that it is so, it would seem that it is only necessary to enumerate the order of the rocks, and compare them respectively with each other. Compare, for example, the marbles of Berkshire with the blue limestones of the Champlain group: the former are in the midst of an immense slate formation; the latter, when all members are present, rest upon the Potsdam sandstone.

But it is unnecessary to dwell upon facts of this kind, when there is a conclusive one; one sufficient to silence all others, namely, direct superposition of the blue limestones upon the taconic slates, as I have exhibited in my actual sections along the Champlain and Hudson valleys.

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* American Journal of Science and Arts, p. 151.

The question of metamorphism has nothing to do with the question of identity with other and distant masses. It may be, and doubtless is true in some sense or other, that heat is not necessarily the agent in metamorphism. But that molecular attraction, exerted under a variety of circumstances and conditions, may and does modify and change the particles from an earthy to a crystalline condition, I believe is the true foundation of the doctrine. I would not restrict this change to the influence of one single cause, caloric, but extend it to all fluids in their several modifications, as water, steam and gas, as well as to the dry heat of contact with an incandescent mass; and still more emphatically to the agency of the molecular forces, by which regular forms are produced, and a constant tendency to arrange symmetrically all the constituent particles of which a mass is composed. With these views, we shall find all rocks metamorphic in a small degree. All the forces of nature have operated upon them as masses, as well as upon every constituent part; and they are not now what they were once, neither will they continue to be what they are now. Those incessant powers of motion which pervade the universe, never cease to act upon solid rocks and thus cause their elements to move: even the light of heaven, penetrating the superincumbent crust, awakens to energetic action those subtle agents.

In closing my remarks upon the Stockbridge limestone, I wish to state that this is by no means the rock which I described in my report as a primary limestone. It is true that both are granular, white and clouded; but the position they respectively occupy is quite different. Thus the primary limestone is always an *unstratified* rock, and is analogous to granite; but when it occurs among stratified schists, as gneiss and mica slate, etc., it puts on some of the characters of a parallel bed, a contemporaneous rock, and so does granite. That it is not one of the blue, or any of the older sedimentary limestones metamorphosed by heat, is fully shown by the inspection of those masses which rise out of the hypersthene rock of Essex, and the granite and gneiss rocks of St. Lawrence counties. In the latter county, the very beds of Primary limestone are exposed by the destruction of the once superincumbent Potsdam sandstone. So far, then, from being one of the sedimentary limestones, its position shows without a question that it can not but have been anterior in age to any of the lower limestones of the New-York system.

These peculiar primary limestones occur in all the northern counties and in the county of Orange in New-York, and in Sussex county in New-Jersey; and they abound in fine minerals, as spinelle, sapphire, idocrase, chondrodite, graphite, hornblende, pyroxene, mica, etc. As to the presence of these bodies, I believe them to have been developed by the same forces as in granite; or, in other words, that they were not, in the great range of limestone in the counties designated, produced by an action upon the rock subsequent to consolidation, that is to say, they are not metamorphic minerals. In this expression of opinion, I do not deny the possibility of their production by the metamorphic process; but having seen the same minerals so frequently in a mass which, under no rational hypothesis could be a blue limestone of the New-York series, I maintain the doctrine that they belong to a limestone *sui generis*, of another age, born under totally different conditions. A vein or mass of limestone comes directly out of the hypersthene rock near the top of one of the mountains in Essex county, filled with many of the beautiful minerals I have named above. How, in this case, I would ask any respectable geologist, can the position of this limestone be accounted for on the assumption that it belongs to the Hudson river series? The difficulty, I would remark in anticipation, is not simply apparent, but real; for the limestone mass does not rest upon, but comes through, the hypersthene rock. This being the fact also in many instances where these minerals abound, I am quite suspicious of a statement that these same identical products are found in an altered blue limestone, in a region too where I know from personal observation that the true primary limestone abounds, and contains the minerals in question.

Among the characters of a primary limestone, I very early fixed upon the presence of graphite, and believe I was the first who noticed the constancy of this mineral in these peculiar beds. Farther observations have satisfied me of the correctness and value of my earlier ones; and as yet I have never seen this substance in a stratified limestone of the Taconic series, where, inasmuch as they are the oldest sedimentary limestones, we should expect to find it, if any where.

Having disposed of the question of metamorphism, as well as of that relating to the origin, age, etc. of the Stockbridge limestone, both of which questions may truly be considered as comprised in one and the same inquiry, I have only to request those who entertain different views, to examine the localities I have referred to in my reports on the New-York rocks, and I have no doubt that the same truths will be enforced on their minds as on my own. I had no theory to support, no preëxisting views to maintain. My opinions, therefore, were those which arose out of the circumstances themselves; they were inductions drawn from facts well considered and well observed.

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§ 7. Brown sandstone or granular quartz.

Characters and varieties. Occurs in insulated mountain masses. Interlaminations with dark siliceous slates. Opinions in regard to the position this rock holds towards the primary schists. Thickness. Mineral contents. Range and extent.

This rock is usually homogeneous, finely granular, and crystalline upon a large scale. That it is a sedimentary rock, I have now but little doubt; though its particles are usually fine, the common earthy sedimentary character exists but feebly.

The common varieties of this rock are,

1. A coarse breccioid or large pebbly mass at the base.
2. A fine granular and even-grained rock, of a brown color.
3. A fine white friable sandstone.
4. Thin-bedded siliceous slate of a dark color.

Another variety is worthy of notice; it is a species of porphyritic sandstone at the inferior part of the rock. The felspar is in small angular forms, and very liable to decompose; and having disappeared in this way, the quartz is left in a porous rough state resembling the Paris burr stones. The dip and strike of the beds usually conform to the other rocks in the system, being from 20° to 45° E., and some beds are vertical. This rock is rarely thin-bedded, and so strongly marked are the transverse natural joints that the bedding planes are often nearly obliterated; the planes are, however, often distinguishable by laminæ of siliceous slate.

The Granular quartz is the least regular in its continuation of any of the rocks of the Taconic system; it generally appears in insulated mountain masses, surrounded apparently by other rocks; still, taking the range of our system as a guide, we find it prolonged far to the north and south, though not continuously.

Some facts have led me to indulge for the present the opinion that two distinct masses exist in the Taconic system: one adjacent to the western base of the Hoosic range; the other, still farther west. The former is the most persistent and important, and rises into mountains from twelve to fifteen hundred feet high. Such is Oak hill, between Adams and Williamstown, Massachusetts; also in the east part of Bennington, Vermont; and Monument mountain, in the south part of Berkshire.

Mica is extremely rare in granular quartz: its surfaces are often sprinkled with talc. It is sometimes interlaminated with a dark siliceous slate, but these laminæ rarely exceed half an inch in thickness. It passes, however, into a rock of this character, and forms a tolerable flagging stone.

This rock, from its extreme hardness, resists the comminuting agents which destroy other rocks; and hence, in the vicinity of its beds, the cobblestones are usually very abundant, and fill the soil to a great depth. These soils, therefore, are often worthless, from the impossibility of removing the stones. Where only a moderate quantity of this kind of stone is present, the land is of excellent quality, and well adapted to corn and rye, particularly the latter.

Some difference of opinion exists in regard to the system to which the granular quartz belongs. Prof. Hitchcock places the rock in the Gneiss, or Primary schists. He remarks, speaking of the topography of the rock, "I have represented all the quartz rock in the State as associated with mica slate, talcose slate or gneiss. It is more or less connected with other rocks, as with limestone in Berkshire, and with argillaceous slate in Bernardston. But in all other cases, except in regard to gneiss and mica slate, it is little more than a juxtaposition of the two rocks; whereas the quartz rock alternates with, and passes imperceptibly into, gneiss and mica slate; and, in fact, it might be regarded very properly as a member of the gneiss and mica slate formations."*

I am unable, from the perusal of the above extract, to satisfy myself that the different beds spoken of are not in reality of different ages. Whether this suggestion is true or not,

* Massachusetts Report, pp. 589 – 590.

I can not but regard the Berkshire quartz rock as a member of the Taconic system. It is constantly associated with those rocks which I consider to be members of this system, and it corresponds rather in dip and strike with the limestones and slates of the same, while it is certainly unconformable to the gneiss and mica slate. Thus, at Arlington, Vermont, the quartz dips N. 20° E. at an angle of 10° – 15°, resting upon the edges of the highly inclined gneiss. Facts of this kind have influenced me to associate the quartz with the Taconic system. How it happens that this rock is in juxtaposition with gneiss, or apparently passes into it, I shall try to explain in a subsequent section.

I have not been able as yet to form an estimate of the thickness of the quartz. The largest mass, and which reposes against and upon the gneiss of the Hoosic range, can not be less than one thousand feet thick. The more westerly mass, and which forms Stone hill in Williamstown, is probably about three hundred feet thick. I give these, however, as only rough approximations.

MINERAL CONTENTS.

Scarcely any rock is so destitute of mineral bodies as this. The whole catalogue seems to be confined, so far as my observations go, to a little sulphuret of iron, sometimes in simple unmodified cubes; in other instances, disseminated in fine particles through the mass. Quartz veins, whose characters are different from the main rock, often traverse it in parallel seams. In the slaty variety, however, where it is near the line of contact with gneiss, I have observed needleform schorl. We have, therefore, in this quartz rock, another instance of one that is quite barren and uninteresting so far as mineral products are concerned; and it agrees in this respect with most of the pure siliceous deposits, for they of all others appear to be the most destitute of veins and valuable metalliferous productions.

RANGE AND EXTENT.

There is more difficulty in tracing the range of the Granular quartz, than that of any of the other members of the Taconic system. I have already remarked that it often appears in heavy mountain masses; but these are quite limited in extent, and disappear in the direction of the strike, suddenly and unexpectedly for such heavy and important strata. This fact has suggested the inquiry whether it exists really as an independent rock; and on this point, Prof. Dewey remarks,* that it may occur only in beds in mica slate; but as it occurs in great quantities, he treats it as a principal rock. He speaks of it, too, as occurring on both sides of the Stockbridge limestone. The hills of quartz run parallel with the general range. The mountain northeast of Williams College, Massachusetts, is fourteen hundred feet high; and being followed eastwardly over its summit towards

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* History of Berkshire, p. 191, Article Geology.

Stamford, it is found to rest directly upon granite: this fact I ascertained as early as the year 1828. Immediately south of this heavy mountain of quartz, in the direction of its strike, is the west ridge of Saddle mountain, composed of Magnesian slate and Stockbridge limestone; but three or four miles directly west of this ridge, is Stone hill, a less important mass of quartz, surrounded as it were with limestone. The large mountain first spoken of, and known as Oak hill, is evidently east of the limestone and other members of the Taconic system at this point; but Stone hill is west of the main bed of limestone, and is also bounded on the west by a narrow belt of limestone which lies against the quartz, as if the quartz was pushed up through it. The Stone hill range crops out about three-fourths of a mile farther north, but attenuated, more slaty and of a darker color. On the south, again, there is no mass of quartz known which can be considered as belonging to the Stone hill range. South mountain, in South Williamstown, which is directly in the strike of Stone hill, is composed of magnesian slate and limestone. We are, therefore, unable to trace this range continuously. The east range of which Oak hill is an important part, appears south in Cheshire, and there forms immense quantities of siliceous sand suitable for glass and for sawing marble; also in Dalton, at the gulph, and at the west base of Washington mountain southeast of Pittsfield. It is continued in Lee, Tyringham, Stockbridge and Sheffield; in Dutchess county (New-York), in Amenia and Dover; and in Putnam and Westchester counties, at numerous points. To the north, the eastern mass appears in mountain ridges in Bennington and Arlington. But how far north this rock may be traced, I am unable to say. That it is prolonged to a great distance I have reason to believe, from facts stated to me by Prof. Renwick, who, while in the employ of the Government in tracing the new provincial lines between the United States and Canada East, passed over heavy beds of siliceous rocks, which, from the characters given of them, I deemed could be no other than the Granular quartz. In the northern part of Vermont, in the direction of Troy and Lake Memphremagog, I did not observe this rock, either in beds, or detached masses forming boulders. The most interesting fact to be observed in these details, is the unexpected and sudden disappearance of a rock which sometimes occurs in masses a thousand feet thick; not by attenuation, as in many other instances of disappearance. The phenomenon may perhaps be resolved on the supposition that they have been engulphed; or perhaps the elevation of the ranges have been unequal: in one place the quartz, limestones and slates were brought up, and the superincumbent limestones and slates swept off, leaving the quartz exposed; in others, the elevation was never sufficient to expose the quartz at all: in the latter case, the only rocks at the surface are the slates and limestones, one or both.

III. OF THE ROCKS WHICH ARE KNOWN TO REST UPON A PORTION OF THE TACONIC SERIES.

For a complete elucidation of the relations of the Taconic rocks, it is necessary that I should speak again of those which lie in a belt of country in the middle portion of Rensselaer county, east of the Hudson river. This will give me an opportunity of adding to the illustrations of one or two interesting points in Washington county. For this purpose, I shall speak of the succession of rocks upon the Western Railway, between Chatham four-corners and Greenbush. At Chatham four-corners an unequivocal slate of the Taconic system makes it appearance, with the regular southeast dip and northeast and southwest trend. The angle of dip is high, and the rock presents that peculiar short wrinkled condition common to it: it contains also the milky quartz in seams. At the village, it appears to dip down steeply, or falls off rapidly from a modestly elevated ridge which skirts it on the east; and in consequence of this westerly plunge of the whole mass, the rock wholly disappears beneath a thick deposit of moderately coarse drift. Proceeding west from Chatham four-corners, upon a tolerable level way, no rock is seen in place for a mile, when there occurs a dark and greenish shale more or less flinty. This shale proves to belong to the Hudson river series; at least it contains an abundance of several species of *Graptolites*, known elsewhere in the series; it is, however, intermixed with red and chocolate-colored slates. These together continue half a mile, or make their appearance a few times in this distance; finally the thick-bedded grey sandstone appears interlaminated, as it so frequently is elsewhere, with fine blue slate without fossils. A succession of this kind continues five miles, following the railroad route; that is, there are frequent uplifts of the shale, and thick-bedded sandstone with its interlaminated slate. Of the character of this rock, there is not the least doubt: it is that which forms the northern slope of the Helderberg, and is elsewhere known as the Hudson river series. Now, although the dip is in a measure in the direction of the Taconic slate, still all sound observations show that it is an unconformable rock. Proceeding to Chatham centre, the succession thus far is clear; but after leaving the latter place, we soon come upon very thin-bedded limestone slate, with silico-calcareous layers and slate interlaminated, but the whole thin, and altogether similar to the Taconic slates. Whether these thin beds are really as I have supposed, is a matter of little consequence, since we soon come upon one in this direction of which there is no question that it is the Taconic slate. This slate continues about seven or eight miles, appearing only occasionally above the drift. In about five miles of the Depot at Greenbush, the Hudson river group succeeds; the Taconic slate again appearing in the form of the shales, and in that of the thick-bedded sandstone mentioned above. Approaching the river, the beds are more disturbed, and of a more equivocal character. They are not only bent, but crushed; and a bed of siliceous limestone six or eight inches thick is not only broken into short pieces, but it is distributed throughout a mass of broken glazed shales for four or five feet in width. To depend on lithological characters for the determination of such a mass, would be unsafe; and it was only after much search in these beds for fossils, and after I had finally succeeded in obtaining those peculiar to the Hudson river shales, that I felt at ease on the subject.

From the above remarks and facts, it will not appear strange that the district through which this section runs should have been set down as wholly occupied by the Hudson river shales, particularly when it is known also that heavy beds of drift conceal much of the rock, that there is a resemblance between the two slates, and that it is only in a very few places that their relations are so exposed as to excite the inquiry whether they may not be different slates in juxtaposition; and even when this question is raised, it is difficult to make real advances towards its solution; so much so, that we are frequently disposed to let it remain still unsettled.

There is one circumstance, however, which I have often observed, and which has been of some service in the examination of a country, viz: Where two systems lie in contiguity, there is a wide space in which no rocks appear: neither one nor the other; but a space which appears to have been a deeper depression than usual, and filled with soil and drift: those on one side plunging deeper beneath the surface; on the other, rising up from deeper depths below. I do not state this as an absolute or universal fact, but only as one which I have frequently observed, and of which several instances have been noticed in this report.

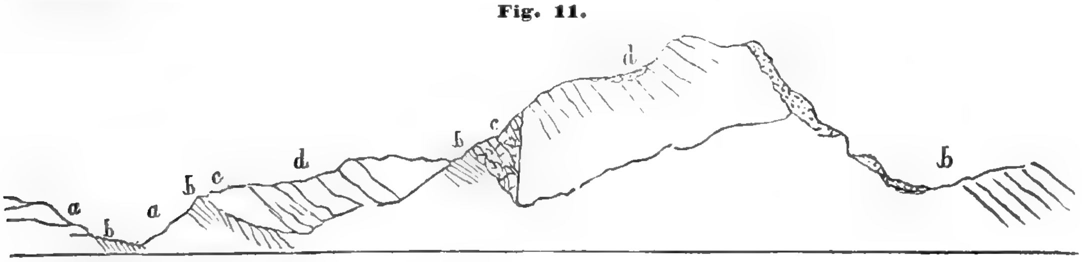
Between the Taconic slates and the rocks belonging to the Champlain division, we find similar relations to those that exist between the Primary schists and the Taconic rocks; that is, the latter members come in longitudinally, or in the direction of strike, and in separate portions of the same rocks, from the former, as in the case of granite in section. In all our examinations of the strata of such districts, we are continually in danger of committing mistakes, especially if we leave much of the surface unexamined, and have ventured upon generalizations incautiously, or without due regard to the systems and to the country under consideration.

Now in regard to those rocks which succeed the Taconic slates one mile west of Chatham four-corners, they can be regarded in no other light than as overhanging unconformable masses to the Taconic system. First, the graptolites are the same as those of Norman's kill on the west side of the Hudson, one and a half miles south of Albany; and no difference can be discovered between the thick-bedded sandstone, and that which crops out on the northern slope of the Helderberg. Proceeding a few miles farther west, we pass over another outcrop of green taconic slates of great thickness, without beds of sandstone as in the Hudson river rocks. The Hudson river rocks are prolonged southwardly towards Hudson, on the railway or adjacent to it. The lower limestones are not exposed; but three or four miles west of Hudson, the birdseye is exposed, and the upper portions of the Champlain group disappear beneath the Manlius waterlimes of Becraft's mountain.

In this vicinity, we have the lower Helderberg rocks, in addition to the Champlain group, reposing upon the Taconic system. The occasional appearance, then, of rocks of another age, under the circumstances and conditions presented at Chatham and Hudson and the intervening country, throws an obscurity over the questions of age, identity, etc., which rarely calls for solution in other places. Nevertheless the evidence is so strong in favor of the interpretation I have given of the relation of these masses, that I have had no doubt of its propriety; although when I published my Report of the Second Geological District, I was not prepared with proofs to sustain it.

Turning the attention of the reader once more to Washington county, he will find a few interesting examples in the relative position of the members of the two systems: the calciferous of the New-York system, and the black slate and coarse taconic slate of the Taconic system. The first example is an illustration of the rocks of Bald mountain. This knob is one of the highest points that skirt the valley of the Hudson upon the east. It overlooks the valley for a great distance; and from it, also, the interior mountains of the northern wilderness at the sources of the Hudson loom up in a bold outline in the north-western horizon. Passing over, however, the magnificent scenery of this spot, I proceed to speak of the structure of the mountain. The diagram fig. 11 will aid in explaining the most important parts.

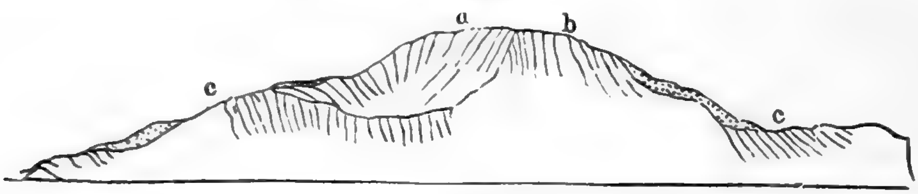
Fig. 11.



The slope *a, b, c, d,* looks to the west. The calciferous sandstone is represented by *d, d.* *c,* indicates the blue portion of the calciferous sandstone I have had occasion to speak of in other places: it forms the purest lime, though it is of a much darker color than that represented at *d.* The taconic or rather black slate appears at *b, b, b, b.* Upon the borders of *c, c,* is a singular dark-brown close-grained sandstone. From these facts, it appears that there must be a double fracture, by which the black slate is exposed at *b, b.* The limestone of the upper part of the mountain is thin-bedded, and alternates with a calcareous slate; the lower mass *d,* is more in keeping with the common calciferous sandstone. A very curious intrusion of fragile greenish slate occurs just above *c,* represented by the perpendicular line; it is two feet thick, in vertical smooth walls like a dyke. As it truly is a slate with vertical laminæ, it is really perplexing to account for its position and formation under such singular relations. The base of the mountain *a, b,* is upon the right, where a hundred yards of the slate is exposed in a continuous line: it is overlaid here by thick beds of tertiary clay, *a, a.*

Another instance of complication occurs in the adjacent hill northeast of Bald mountain. Fig. 12 is a section illustrative of its structure.

Fig. 12.



a. Calciferous sandstone: towards *c*, on the west, it dips moderately to the east; but ascending the ridge, the dip increases, and finally at *a*, the summit, it is reversed, or to the west; but here it comes in immediate contact with the coarse taconic slate, *b*, dipping steeply to the east. Well characterized taconic slate crops out on the western slope, just above the main road, covered partially by debris.

I have introduced this illustration for the purpose of clearing up some difficulties which might arise hereafter in the examination of this or the neighboring hills, where the calciferous sandstone apparently plunges beneath the taconic slate, when viewed in certain positions only; for if only the western slope should be compared with the eastern, without a careful examination of the summit of the ridge, a very false view would be taken of the position of the rocks forming this hill.

IV. THE TACONIC SYSTEM IN RHODE-ISLAND.

Position of the Smithfield limestone: it is the Stockbridge limestone. Other members of the Taconic system. Only a fragment of this system remains, it having been probably destroyed by denuding agents. Debris found in the soil, and in the rocks composing the Cumberland coal basin.

In July of the present year (1844), I was induced to visit the State of Rhode-Island, principally for the purpose of examining the Smithfield limestone, a rock which for a long time has been known in the market as furnishing an excellent lime. I had often made the enquiry whether this rock is an equivalent of the Primary limestone of St. Lawrence and Essex counties; or whether it is of the age of the Stockbridge limestone, the marble of the Taconic system. The satisfactory solution of this question, I deemed of sufficient importance for a journey to the place; inasmuch as no one, so far as I had access to printed publications, had expressed themselves very clearly on those points in which I was the most interested.

The Smithfield limestone lies in the valley of the Blackstone river, about ten miles north of Providence. It occupies but a small area, and lies in the midst of the primary rocks. The limestone beds are all situated upon the west side of the Blackstone: on the east side is the Cumberland coal basin. The coal rocks, however, are not confined to the eastern side of the river, but cross it at Attleborough, and extend south to Providence and even to Newport upon the Narraganset bay, their western edge running nearly north and south. An immense quantity of drift has been deposited over this part of the State, which conceals the rock except in a few favored places. The limestone, together with its associates, lies upon the western border of the coal rocks, beneath which they pass. With these general remarks on the position and relation of the Smithfield limestone, I proceed to speak of its characters, the period of its formation, and the rocks which appear to be its true associates.

The rock in question, then, is a white or clouded limestone, with a finer texture or grain than the Berkshire marbles, but, like them, contains in mixture silex and magnesia. Some portions of the rock are clouded and coarse, and with layers or strata very clearly developed; thus removing all doubts in regard to the stratification of the rock. Being, however, in intimate relation to igneous rocks, it has undergone a change in texture, and acquired a compactness and hardness not common to sedimentary limestones. In addition to which, we find developed those peculiar minerals which have been denominated *saussurite* and *nephrite*. These masses so intimately associated with the rocks, or developed in it, are hard, compact and translucent, with a bluish tinge. They are not, however, in immediate contact with the igneous masses. In a few places, again, fine greenish talc, in large specimens and in implanted masses, lies between the layers. The talc is in much greater quantities than at any of the beds of limestone I have examined elsewhere. Without dwelling, however, on those minor differences which a peculiar position seem to have been instrumental in producing, I have little hesitation in saying that this rock is clearly of the age of the Stockbridge limestone. It differs from the Primary limestone of St. Lawrence and Essex counties, New-York, in being stratified, and in the absence of graphite, spinelle, or those peculiar minerals which are so common in the latter rock.

Having satisfied myself as it regarded the age of the limestone, another question arose, whether other members of the Taconic system were associated with it; for if the opinion I had formed of the limestone was correct, then some of the other members of the same system ought to lie in proximity to it.

For the determination of this question, I proceeded west from the limestone beds, and observed first a slate possessing in general the characters of the magnesian slate of Berkshire, Massachusetts. It occupies a very narrow belt, being restricted by great beds of granite upon the west, upon which it rests. At or near the junction of the two rocks, the slate and granite, I found an altered belt of slate, about one hundred yards wide. Again upon the east of the limestone a remarkable magnesian slate appears, altered to an imperfect serpentine in a few places; in others, to an imperfect epidote, or a mineral substance whose color approaches the peculiar green of epidote; not, however, in well defined masses, but in diffused green patches. Notwithstanding all the alterations the rock has undergone, it still preserves the general character of the Magnesian slate, and is a perfect example of it throughout most of its body.

There still remained other members of the Taconic system, which I had not yet discovered in this narrow basin or trough. As the granite appeared in a heavy body upon the west of the slates and limestones, I pursued an easterly route for the discovery of other members of the system. I was led upon this direction, too, from having seen boulders of brown sandstone in the drift of the Blackstone valley, which increased in size and numbers towards the river. Pursuing, therefore, this direction, I soon came upon an extensive deposit of this rock in place, about half a mile north of the Cumberland coal-field. On the direct route from Smithfield to Cumberland, the quartz, if it exists, is concealed beneath thick beds of drift. The quartz is upon the eastern side of the Blackstone. As developed in this valley, it is a fine brown granular quartz, interlaminated with slate, or rather alternating with a species of magnesian slate, but of a darker color and more siliceous than this rock usually is. The lower mass of quartz is about fifty feet thick: it is then succeeded by ten feet of slate, about five of quartz, and then about seventy-five of slate, which, however, is very siliceous, and interlaminated with some beds of quartz. Without entering upon minute details of the alternations of these masses, I estimated the whole thickness at five hundred feet. The quartz trends N. 35° E.; its angle of dip about 35°. Near Mr. Whipple's tavern, the trend is N. 10° W.; dip, 80° E. At half a mile north of Whipple's, the trend is N. 55° E. A fracture traverses this rock in the direction of N. 15° W., in which direction there are low ranges of rounded hills.

Having traversed the slate, limestone and quartz, on a route which is nearly perpendicular to their strike, I had reason to believe that the remaining members of the Taconic system, which I was familiar with in New-York and Massachusetts, were wanting here. I made no farther examinations than those I have already detailed, having succeeded in discovering three of the members of the system, the inferior ones in the limited area of this part of the valley of the Blackstone, confined to a trough hardly exceeding four miles in length by two or two and a half in breadth.

The annexed section exhibits the relation of the Taconic rocks of Smithfield and Cumberland, together with the adjacent rocks upon the west and east.

Fig. 13.

G. Granite. *a*. Altered magnesian slate. L. Limestone. *b*. Hornblende. *c*. Limestone. *d*. Dyke or thin bed of hornblende, ten inches thick. *e*. Great bed of limestone. *f*. Altered slate resembling serpentine, with small patches of epidotic looking substance. V. Valley of the Blackstone river. *i*. Granular quartz, interlaminated with siliceous slate. K. Conglomerate of the Coal formation, or it may be the conglomerate of the Old Red sandstone.

The trap dyke represented in this section has the aspect of hornblende, but it has also the soapy feel of many of the varieties of the trappean rocks. Of the altered magnesian slate on the east of the limestone beds, I ought to say that while it would not be difficult to select tolerable specimens of serpentine, talc and epidote, still as a whole there is nothing differing much from the rock, very distinctly developed. Those individual minerals are merely slight changes in a rock originally magnesian; but how much of these apparent changes are due to the nature of the original materials of the rock, and how much to metamorphic action, does not clearly appear even from an inspection of the rocks themselves.

In conclusion, I remark that we have in this region a fragment of the Taconic system. The limestone is inclosed in magnesian slate, as in Berkshire (Massachusetts), and the quartz is also accompanied with a slate whose characters reminded me strongly of that associated with the quartz rocks of Stone hill in Williamstown. It is to be borne in mind, however, that these rocks are modified by intruded igneous masses. But then these accidents, even although taken in connection with the limited extent of the rocks, do not destroy the system: they ought still to be considered as representatives of it. That they have been vastly more extensive than their present area, is proved by the immense quantity of their fragments which fill up, as it were, the valley of the Blackstone; and, in addition to this, they seem to form by far the greater portion of the materials of the Coal formation, especially the conglomerate, which is made up of granular quartz, and cemented by the magnesian slate.

From these two facts, it appears that these rocks have for a long time been subjected to the action of those agents which destroy the already consolidated materials. We need not wonder, then, at the small space which they occupy; though it must be recollected that they have furnished materials for another system, as well as an immense amount of debris in the valley of the Blackstone.

The character of the soil arising from the decomposition of the rocks I have now described, resembles very closely that of Berkshire (Massachusetts), and of many other localities where the same rocks occur. One of the results of the decomposition of the slaty limestone, is the formation of yellow soil, in which yellow ochre predominates very largely: it is a result identical with that which has taken place in the Taconic range, though upon a much larger scale. The result I refer to, is the formation of the hematite beds; and it appears from this and many other examinations I have made, that this ore is one of the products of these slaty limestones, or those in which talc abounds, and with which we always meet with more or less of ferruginous matter.

V. THE TACONIC SYSTEM IN MAINE.

Remarks on the geology of the country between Portland and Waterville. Origin and position of the granite used in construction. Slate of Waterville: similarity of all its subordinate beds to those of New-York. Breadth of the taconic slate. Reference to the Nereites of Waterville. Similarity of the Kennebeck valley to the Hoosic valley in New-York. General remarks on the rocks between Waterville and Belfast. Examination unsatisfactory at Belfast. Rocks of Camden. Megunticook mountain. Fox islands. Limestone of Thomaston.

The valleys of the Kennebeck and Penobscot, together with a wide belt of country upon the Piscataqua, furnish many important facts in support of the Taconic system. I was first convinced of the importance of the rocks in these valleys, from a specimen of slate which was furnished me by my friend Prof. A. Hopkins, of Williams College, from the Kennebeck at Waterville, upon which I observed peculiar markings, so strongly resembling those of the *Nereites* figured by Mr. Murchison in his Silurian System, that I could not doubt that they belonged at least to that genus. As this slate appeared identical with the Taconic slate of New-York, I deemed it important to visit the region which furnished the specimen. I accordingly visited Waterville, going by way of Portland, for the purpose of passing over as much of the adjacent territory as possible. Before proceeding to relate the facts concerning this slate, I will avail myself of the opportunity to say a few words upon the rocks between Portland and Waterville.

The rocks in and about the city of Portland, and onwards through Brunswick, belong to the Primary system. They consist of schists, gneiss and mica slate, mostly of the same character as those of Massachusetts. They are traversed like them with coarse granitic veins, abounding in tourmaline and other minerals peculiar to such veins. Besides the coarse variety of granite, one of a beautiful light grey is associated in beds with the same schists. This variety is almost entirely destitute of the fine minerals so abundant in the coarser kinds, and which traverse the schists in rather narrow veins. I hardly need remark that it is the grey and uniform rock which has been so much employed in construction. The most interesting fact which I observed in relation to this rock, was, that it occupies usually the summit of the hills, appearing there as the capping stone. On examining several of these hills which had been opened as quarries, I found that the granite was quite limited, and that the entire mass had been removed; that the bed rested originally upon the edges of the nearly vertical mica slate; and, in fine, all that remained of those beds, were the veins through which the granite seemed to have issued while in a molten state. These veins are from one or two inches to a foot in thickness. I know that this is not a new fact in geology; but I had not seen any statement to this effect in the publications of the day. Granite of the same kind, but of a coarser grain, forms large beds in some parts of Massachusetts, and has probably a similar origin. In New-York, granite seems also to have overflowed some of the beds of primary limestone.

I have introduced a notice of the primary rocks, and of their igneous character, principally for the purpose of preparing the reader to expect a variety of derangements in a system of rocks of a more recent date than the primary schists. I refer to the taconic rocks; for as the latter are surrounded by those ancient igneous formations, it would be very remarkable if they should escape the general derangements which are so common in the former. In fact we find changes in them of the same kind as those of which I gave some account while speaking of the Taconic system in Rhode-Island.

§ 1. Taconic slate.

In describing the Taconic rocks of Maine, I shall pursue the descending order, describing first those which appear to me the newest. The slates at Waterville were the first to which I directed my attention. They are of a fine greenish color, nearly as even-bedded and as fissile as roofing slate, and very little liable to decomposition. They are, however, stained brown in some instances, by the decomposition of pyrites which is disseminated in microscopic crystals through much of the rock. Among the crystals, I believe I can recognize also the octahedral iron. I consider the presence of these crystals important, inasmuch as they must have been formed by molecular action subsequent to the deposition of the rock. In the magnesian slate, octahedral iron and sulphuret of iron have been formed apparently under the same conditions, but in much larger specimens. In the taconic slate at Waterville we find the fossils upon the same layers, showing very satisfactorily that the presence of metallic crystals is no objection to the view I have taken of these slates, particularly as it regards their sedimentary character. Interlaminated with the fine greenish slate are calcareous bands, though by no means rich in calcareous matter. They are thin-bedded, and scarcely differ from the beds described in New-York. I may go still farther, and say that we find here the same series of beds in the taconic slate as in New-York. I noticed in particular the coarse brecciated beds, similar to those formerly called *greywacke;* consisting, however, of a diversity of materials, as angular grains of quartz stained with chloritic matter, and disseminated carbonate of lime, which often disintegrates and falls out, leaving rather a rough spongy mass of silex or quartz stained with oxide of iron; and what I considered as quite remarkable, was the existence of hemitropic crystals of albite in the same coarse beds, under the same condition as in New-York. These beds are traversed by thin seams of quartz, which give the mass a chequered appearance, looking at a distance like the sparry limerock. All the subordinate masses run parallel with the beds of the slate: when one is contorted, the other partakes of the same sinuosities.

The points that I first examined at Waterville, are not far from the centre of the range, the most important of which is that upon the banks of the Kennebeck near the village, where the *Nereites* are found. The slates are nearly vertical, with only a slight dip to the east: their trend is N. 10° E., varying, however, from this direction to northeast and southwest. At West-Waterville, five and a half miles west from Waterville proper, the same thin beds of slate appear, interlaminated also with silico-calcareous layers. The intervening country is moderately ridged with low hills, and the rock only appears occasionally, but enough of it may be seen to convince the most sceptical that it is but one continuous rock. One or two miles west of West-Waterville, the taconic slate is succeeded by the primary schists with granitic veins, as in the country between Waterville and Portland. In the direction of their strike, they pass onwards to the Piscataqua river, where the fine roofing slates abound, which are described by Dr. Jackson in his Report on the Geology of Maine.

In the position of the roofing slate in Maine, we have another fact analogous to what actually exists in New-York, namely, the roofing slates are confined to beds subordinate to the taconic slate; and it is to be remembered, too, that as yet no slate fit for roofing has been found in the Hudson river rocks.

Having examined the slate in a westerly direction as far as seemed necessary, in which examination I was assisted by Prof. Loomis of Waterville College, I proceeded across the strata in an easterly direction towards Belfast. On this route the slate continues about seven miles. No variation of character in this rock appears in this distance: it consists, as at Waterville, of alternating hard and soft layers or beds, together with the siliceous, calcareous and coarse brecciated beds. Towards China, seven miles from Waterville, the rocks assume more the character of the primary schists, but the precise point where the change occurs was not observed.

From the exposition of this rock and its beds, it appears to be at least fifteen miles wide, leaving out of view the equivocal portion in the vicinity of China. On placing specimens of the slate and its beds side by side with those of New-York, it is impossible to discover any essential difference between them. It is true, however, that as yet species of the same *Nereites* have not been discovered in New-York.

It was in the vicinity of Waterville that Prof. Loomis discovered the fossils referred to on page 69.

The character of the country over which the taconic slate prevails, resembles that of Rensselaer and Washington counties in New-York; and the valley of the Kennebeck at and above Waterville, resembles that of the Hoosic. Some of the best farming land in the State lies in and adjacent to this valley, which is productive in grass, and will probably soon supply the southern cities with hay.

Omitting for the present the farther consideration of the rocks of the Kennebeck, I observe, that between China and Montville, mica slate and gneiss, together with granitic veins, are the only rocks that make their appearance; and again ten miles west of Belfast, a still coarser mica slate occurs, charged with garnet, schorl, hornblende, and large masses of felspar: the rock dips southeast. Five miles west of Belfast, a much finer talcose slate is the surface rock, a slate approaching in its characters the magnesian slate of the Taconic range in New-York.

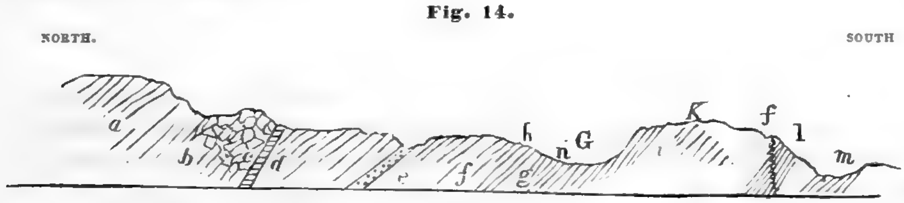
At Belfast, upon Penobscot bay, the same rock occurs, but much more disturbed than at points intervening between Waterville and Belfast; and it is for this reason that the geological position of these rocks is still doubtful. They may be talcose slates of the primary schists; or they may be magnesian slates altered by subterranean and other forces, so as to disguise their true character. There is still another difficulty in determining satisfactorily the position of the rocks at this place: it is their concealment by drift. We find exposed at a certain place, for example, a small portion of a mass which contains garnet, hornblende, etc.: it is, so far as can be determined, a primary schist. At the distance, however, of a quarter or half a mile, another rock is partially exposed, which is a magnesian slate, without garnets, hornblende, or other of the essential characters of the talcose slate just alluded to. In these cases, the great difficulty is the concealment of the relations of the two rocks by soil and drift. Now in this and some other cases, the doctrine I am disposed to maintain is that different rocks, differing as it regards age, but agreeing in respect to lithological character, may be formed in proximity; but of this I shall speak hereafter.

The coarse schists at Belfast abound in andalusite in very perfect crystals. They may be found upon the beach about half a mile north of the village. They are reddish, and more like foreign andalusite than any I have seen.

Not finding the Taconic rocks sufficiently well exposed or developed at Belfast, I proceeded to Camden. I had been informed that limestone was one of the principal rocks at this place, a circumstance which was deemed of sufficient importance to authorize an examination.

In the rocks of Camden, I found much to support and sustain the views I had previously formed of the independent existence of a system of rocks above the Primary schists, and below the Silurian system. That the relations of the rocks at this place may be understood, I have introduced a section which embraces the entire series in the order they occur. It crosses a tongue of land intervening between the harbor at the village of Camden, and a small bay or harbor formed by Goose river. By this section, I am able to refer at once to the rocks and their position.

Fig. 14.



a. Wrinkled magnesian slate. *b.* Limestone. *c.* Trap dyke. *d.* Hard siliceous slate. *e.* Granitic vein. *f.* Fine slate. *g.* Coarse slate, with imperfect staurotide. *h.* First mass of granular quartz. *i.* Slaty contorted quartz, passing into a rock containing macles. *K.* Fine granular quartz. *l.* Slate with macles. *n.* Granular quartz. *G.* Goose river. *F.* Fracture and uplift. *m.* Magnesian slate.

An inspection of this section, which comprises an extent of about three quarters of a mile, furnishes an epitome of the facts disclosed by the rocks upon this range. The first mass *a* is the magnesian slate, much wrinkled, and containing masses as well as seams of quartz: it is the north portion of the uplift, where the descent becomes rapid towards the river.

b, is the Stockbridge limestone, clouded, lumpy as it appears upon a weathered surface, intermixed with quartz, siliceous veins, talcose matter, etc. Its beds, when worked, offer veins of calc spar, and imperfect veins of magnesian matter, which appears to result from the decomposition of felspar. The soft matter contains dodecahedral crystals of carbonate of lime, with rough surfaces, which appear to have been formed in the soft matter after its decomposition. The same material is found in numerous places in the limestone at Williamstown, Massachusetts. I have called it magnesian, though probably it is merely a porcelanous clay.

A trap dyke traverses the hard slate, succeeded very soon by a granitic vein. *f* and *g* are portions of fine and coarse slate; in the latter, imperfect crystals or macles of brown staurotide appear. Some of the faces may be made out; they possess only the general form of a crystal, but are disclosed by weathering. Nothing at all determinate appears by fracture.

h. At this point in the section, a mass of quartz comes in, of a bluish color; grain and texture that of the common granular quartz. It is sixty or seventy feet thick; and from its presence and relations, I have been led to entertain the opinion that two distinct masses of quartz belong to the system. This fact is borne out by the rocks of Berkshire, Massachusetts. Two masses, for instance, appear which are not in the same range, though it is not clear that one is superimposed upon the other as at Goose river, Maine.

m. Magnesian slate.

K. Fine brown granular quartz, portions of which are conglomerated: it is the principal mass of quartz, possessing all the characters of the same kind of rock in Massachusetts, Vermont and New-York. It is interlaminated with a dark fine siliceous slate, occurring in mass, though much contorted. Portions resemble the talcose slates, in which, as in Rhode-Island, a greenish granular mineral appears, more like epidote than any thing else. Bands of yellow slate also appear, resembling those of Massachusetts which furnish the ochry iron.

At *f*, after rising up from the gorge of the river, and passing over the succeeding ridge some forty or fifty rods, a fracture appears, which brings the magnesian slate nearly in contact with the quartz over which it lies. It contains at this point also imperfect macles. That the quartz is beneath this mass of slate, is proved by another fracture nearly at right angles to this one, and but a short distance to the westward, where both masses are brought up, the quartz being beneath, and bearing the slate with its peculiar imperfect minerals. The dip and trend in this case is changed to the west and north.

The thickness of the limestone at this exposure is about two hundred and fifty feet. The portions of the beds adjacent to the others are more or less slaty and impure. The stratification is extremely obscure; and were it not for interlaminated slate or other beds, it would be impossible to determine the direction of dip. It is difficult to discover the cause of such a condition, which is one that is quite common to limestones of this period. Even in the Massachusetts beds, the stratification is not always distinct.

There is nothing peculiar to the main bed of quartz. It is interlaminated with a siliceous slate; and like all other beds, this is extremely barren of minerals. The dip is north, or conformable to that of the upper rocks.

The most interesting mass of this rock is west of Camden village, where it forms Megunticook mountain, an eminence from six to seven hundred feet high. This mass I supposed to be the lowest, and it can not be less than five hundred feet thick. Dip southeast, at an angle of fifteen or twenty degrees. The whole mountain seems but a brecciated or conglomerated mass of pebbles, cemented together by a fine siliceous paste. The layers are jointed: one set runs N. 75° W., and another N. 10° E.

The pebbles are usually partially rounded, although they appear as if they were all angular. Actual inspection, however, shows that while some are partially worn, others are sharp and angular. From an examination of these pebbles, they seem to have been derived from the quartz of the mica slate and granite. I was unable to discover limestone pebbles in any of the strata. Abundance of grey mica, in fine scales, gives a glimmering aspect to some portions of the rock.

Megunticook mountain rises rather abruptly from a rolling country, and appears insulated from other rocks of the Taconic system. A few rods from its steep sides, a mica slate appears, the surface of which is grooved by diluvial action. I could obtain no evidence that the quartz is embraced in this depressed mass of mica slate; the whole appearance led me to infer that it rested upon the slate. The ground upon which my opinion in this matter is founded, is the difference in the strike and dip of the two rocks: thus the quartz, as has been stated, dips at a very moderate angle to the southeast; the mica slate, on the contrary, is nearly vertical, with a strike N. 60° – 70° W.* The two rocks therefore have no coincidence, as they ought to have if the quartz was enclosed in the slate. This result, too, is agreeable to what is elsewhere observed, particularly along the western face of the Green mountain range at Arlington, Vermont. It is true that Prof. Hitchcock considers the quartz as embraced in mica slate in Berkshire. Not to maintain an opinion contrary to high authority in this case, I will only remark that I do not think that it is ever embraced in the primary schists, or those of the Gneiss system. This mica slate also bears the same characters, and has the same trend and dip as the other masses associated with the gneiss and granite passing between Searsmont and Belfast. What appears to be the fact, therefore, is that we have a primary base underlying the whole region, and forming occasionally wide belts; and in these belts the true Gneiss or Schist system is comprised,

* That there is no mistake in determining the dip of the quartz, is shown by the position of the pebbles, which lie with their major axis parallel to the planes of bedding, as is always the case upon a pebbly beach.

which, however, occasionally appears, as at Camden, above all the other rocks, and then sinks deeply and disappears beneath them. This state of things causes a great deal of perplexity, confusion and disagreement among observers; and it will require the utmost care and attention on the part of all, to reconcile the discrepancies and differences of opinion on this question. On many of these subjects, much is yet to be learnt in this country; and though we are here pushing our researches among the newer rocks with great zeal, much remains to be done among the older, and to be learnt in relation to the origin of rocks and parent beds.

§ 2. Fox islands.

The islands called *Fox islands*, lie off from Camden twelve miles. They form low ridges, or high reefs or outliers from the main land, and are particularly well located as fishing stations.

The formation of these islands is very similar to that of the main land. The principal difference consists in the greater proportion of metamorphism exhibited in the islands. The slates are particularly altered. The cause appears upon the spot; few places furnishing such a number of dykes as are found on some portions of the coast. The effect exhibits itself in a hardening of the strata and a crowding together of the masses, and in the development of many hard oval nodules, and in many instances imperfect crystals of felspar.

Those slates which are unchanged are thin beneath and usually dark colored, and very often charged with sulphur, which imparts to them that peculiar character that has given them the name of *plumbaginous slate*. When only a slight change has taken place, there is simply a glossy surface, a sort of resinous lustre.

The dykes are the ordinary greenstone, though coarse, yet nothing peculiar; but they contain many nodules of smooth quartz much like water pebbles, solid throughout, or with merely a slight cavity in the centre. These break open readily, and some become loose by atmospheric action. The islands, however, are composed of the magnesian slate and trap dykes, twenty five or thirty feet wide, to which must be attributed the strange metamorphosis the rocks have suffered both in texture and mechanical arrangement.

We are unable, in consequence of the concealment of the rocks in this direction, to estimate the width of the Taconic system: they dip N. 55° W. The system ranges up the Penobscot into the interior of Maine; but in consequence of the proximity of igneous rocks, and the changes which they have undergone, as well as their resemblance when thus changed to the primary schists, it may still be difficult to mark out the distinct belt of country over which it prevails.

Having completed my examinations at Camden, I proceeded to Thomaston, where for a long time beds of limestone have been wrought for marble, but more extensively used and burnt for quicklime. I had the same intention as when visiting the Rhode-Island quarries of limestone, namely, the determination of the age and relations of the rock. Thomaston is about seven miles southeast of Camden, and lies in the direction of the range of the Taconic system. Yet in a region where igneous action has been so rife, and where, as has been stated in the preceding pages, plutonic rocks are ready to meet the observer on all sides, it would not be safe to infer the place of any of the limestones without an actual examination. In this case I should have been right in locating the rock in the Taconic system without an examination; for only a mere inspection was required to see its identity with that at Camden, and its equivalency with that of Stockbridge, the special type of this species. I do not deem it at all necessary to repeat the characters of the rock; but it is proper to say, that like the same mass at Camden, it has suffered by intrusive rocks. One of the quarries is traversed by a huge dyke of greenstone, which remains an upright wall about fifteen feet thick: its direction is N. 40° E. The slates in connection are the magnesian: their strike is northeast, with a curved dip to the southeast.

VI. THE TACONIC SYSTEM IN MICHIGAN.

INFORMATION FROM DR. DOUGLAS HOUGHTON, RELATIVE TO THE DEVELOPMENT OF THE TACONIC SYSTEM IN MICHIGAN.

After the preceding pages were ready for the press, I received from Dr. Houghton the interesting information that this system is well developed in the State of Michigan. I give here the account which he obligingly furnished me of the rocks in question.

The Taconic system is largely developed in the western and central parts of the upper peninsula of Michigan. The slates of the formation are finely exposed along the western boundary on the line of the Menomene river, which cuts across the formation. East of this, and near Lake Superior, the granular quartz makes its appearance in hills of an elevation of several hundred feet. This formation trends northeasterly, and probably in a direction nearly parallel with that in New-York. I am not furnished with details in regard to the separate, or subordinate masses. It is interesting to find the same rocks in so many independent fields; and I may add, for the purpose of dispelling doubts in regard to the identity of the slates of the peninsula of Michigan and New-York, that on showing Dr. Houghton some of the flagging stones of the Taconic slate with fucoidal impressions, they were recognized at once as the same species of fossils he had observed in the slates of the Menomene river. Another fact stated by him is that he has observed many localities where the slates of the Taconic system pass beneath the Potsdam sandstone, the oldest rock of the New-York system. It would be difficult to add to the weight of this testimony, in regard to the separate and independent existence of a system of fossiliferous rocks of an age anterior to the Silurian or New-York system.

VII. DERANGEMENTS OF THE TACONIC SYSTEM IN NEW-YORK, MASSACHUSETTS AND VERMONT.

§ 1. Difficulty of distinguishing some rocks which conform in strike.

The relations of the members of this system are without doubt preserved over the whole extent comprised within the area of Rensselaer and Washington counties in New-York, and Berkshire and Bennington counties in Massachusetts and Vermont. Here at least the succession and parallelism of the rocks are maintained generally; and in deciding what rocks really belong to the system, we are not embarrassed by intruded masses. The geologist may pass immediately over a succession of taconic rocks by and on the route of the macadam road from Troy to East Bennington, a distance of thirty-five miles. The succession is uninterrupted, so far as intruded and plutonic rocks are concerned; and therefore all those masses or rocks over which he will pass in this easterly route, and which are conformable to and succeed each other as represented in the table (page 63), I conceive to belong to the Taconic system, commencing at Troy with the Taconic slate, and terminating in East Bennington with Granular quartz and the Stockbridge limestone. We end here with the granite and gneiss of the Hoosic mountain. If this undisturbed condition prevailed universally, there would probably have been but one opinion in regard to the independence of this system. It was very natural, in the early days of geology, to regard those rocks as identical which looked alike; and hence when it was known that the talcose slates of the Gneiss system differed but a fraction from those of the Taconic, it was to be expected that they would all be placed upon the same list, especially when it was observed that real primary schists ranged side by side with them in a few localities. An uninterrupted succession, however, does not prevail; and it is my business, in this place, to give some details of those interruptions which occur in New-York.

It is well known that the range or strike of the Taconic rocks is nearly parallel with that of the primary schists upon their eastern border, a fact which has had its influence in observing the true age of the rocks under consideration. But this is not all: wherever, from any cause, the lower rocks have been elevated, the ridges formed thereby lie also parallel, and appear as a part of the system of rocks among which they range, unless indeed the intruded rock is an unstratified one, as granite or trap. When gneiss or mica slate forms a range, it is with extreme difficulty that we can persuade ourselves that the talcose looking slates are not also parts of the Mica slate and Gneiss system.

The great point of difficulty, therefore, in studying the Taconic system, is where the members are respectively separated from each other by intervening rocks whose lithological characters closely resemble those of this system. This is particularly the case at those points where the highland ridges of Orange, Rockland, Westchester and Dutchess counties send up their spurs to the north. In conformity with this fact, I may state generally that the highlands of the Hudson separate and divide the Taconic rocks as a whole. They are not intruded by transverse rents in the manner of injected or plutonic rocks, but are simply separated in the direction of their strike, or nearly so, as it would seem by an uplifting among them of inferior rocks in the form of parallel ridges. By this means the taconic slate is carried more westerly than its general strike at the north; and it is by this westerly thrust that it crosses the river near Poughkeepsie, ranging southward so as to underlie the belt of country to the west of Newburgh for six or eight miles; while the lower or easterly members of the same system pass to the east of the primary chain of the Highlands, and do not appear upon the banks of the Hudson till that chain is passed. A good example of an arrangement of this kind is furnished at the Rocky Glen Factory in Fishkill, upon the creek of the same name. The separation of the adjacent masses is effected at this place by a low ridge of granite, which comes up in the form of a slender spur from the Highlands four or five miles south, where of course it is wider, while at the Glen it has become attenuated, and, in the course of a mile or two, disappears beneath the taconic rocks. The annexed section explains the arrangement.

Fig. 15.

a. Slate. *b.* Granite. *c.* Limestone. *e.* Fishkill mountain.

In this section, the granite is pushed upward so as to intervene between two rocks (which in other localities are in contact), and runs an unknown distance in this relation. The width of the granitic ridge is about one hundred yards. It contains a large portion of greenish or chloritic matter: the felspar is flesh-colored, but, as a whole, it has quite a resemblance to trap. If now we substitute in imagination a ridge of gneiss or mica slate for the granite, we should be very likely to consider it a case of interstratification or interlamination of rocks of the same age; and were this to occur in the eastern border of the system adjacent to the Hoosic mountain, few would doubt that, in truth and reality, slate, gneiss, and limestone were interstratified, and therefore belonged to one and the same system; and should we substitute quartz for the gneiss, a still stronger case would be presented, and we could then hardly doubt the truth of the supposition which has been advanced. We may believe that these very arrangements do occur, and that mica schist actually protrudes upward among the newer slates, appearing like a member of the formation; but it is easy to see that, after all, such a conclusion may be false. Not only may an inferior rock be forced between two adjacent though different ones, but it may come up also between the strata, and thereby separate portions of the same rock widely from each other. This being admitted, it leads us still forward to more complicated cases; for by changes of this nature, the masses become more exposed to abrading influences, especially if they have been exposed to what is termed diluvial action, and patches have been worn or cut through, showing the lower rocks in the same strike. Now in a system as old as the Taconic, we must admit its great liability to be deranged, and its members to be changed in various ways; in ways as numerous as the physical agents themselves, fire, water, frost, abrasions, disintegration, etc. It is therefore really to be expected that difficulties should occur in the adjustment of its members; but these by no means appear insurmountable, when we are once in possession of all the facts relating to the system.

The doctrine which I wish to inculcate in the preceding remarks, is, that a system of rocks may be rendered obscure by a parallel division of its beds, or by a parallel separation of its individual members: they may be so divided as to be worn out by the agents or powers of nature, or become insignificant, or separated so far asunder as to be lost sight of; and the older any system is, the more liable is it to suffer by these accidents. The Taconic system has especially suffered by these causes; and in consequence of its proximity to other systems and rocks probably of a similar origin, many perplexing questions arise, of which other systems are entirely free.

In studying the rocks of this or any other system, I select those districts where there is the least disturbance. By this course, I am enabled to learn, not only what the members of the system are, but also their true order of succession. In this system, I have particularly examined the district marked out at the head of this article, as it is here that few if any intrusive rocks of any kind occur; and I find a certain number of them lying in parallel bands, which on both sides, the east and west, prove unconformable to the two systems lying one above the eastern system of schists, and the other below the shales that constitute a part of the western system, the New-York or Silurian.

Now wherever I find these members, although they may be separated from each other as they are at the Highlands, I am determined still to call them by their right names; though I am ready to express my fears that some of my favorite bantlings have been so much altered in some localities, that I may fail to recognize them. I suspect, too, that it may happen in some cases that only the fragments of the system have come down to us, so that it will be impossible to bring together the remnants in such a condition as to make even a tolerable appearance on a map.

I have only a few more words to say in this connection, namely, that the difficulties attending the adjustment of the rocks of the Taconic system cannot be appreciated without a tolerable knowledge of the characters of all the rocks with which they lie in juxtaposition. Very little embarrassment is occasioned by the presence of gneiss or mica slate near any of the members of the New-York system, so far at least as to distinguish one from the other; but not so with the rocks under consideration, for reasons which I have already given.

§ 2. MURCHISON'S SILURIAN RESEARCHES.

It is no new thing in geology, for rocks, where they come together, to conform nearly in dip and strike, though they may be of very different ages. A case in point is given in the Silurian Researches, where the Coal measures conform so nearly in their strike with the Cambrian rocks, that the unpractised geologist would be misled by appearances. I give the passages entire, as they contain important matter. The first is introduced by stating that the Salopian coal measures repose on rocks of all ages, from the Mountain limestone to the Cambrian rocks inclusive. "This collocation," the author remarks, "which in "Shropshire cannot lead us into error, has been productive of confusion in those situations "where the coal measures put on the lithological aspect of the older deposits, and at the "same time rest directly upon them; and if there is no striking want of conformity between "these masses, their separation becomes a subject of difficulty to persons not habituated "to such phenomena." And he goes on to state, that at Nolton it would be difficult to define the boundary between the culm beds and the lower silurian shale and sandstone, in consequence of the striking coincidence in the lithological aspect of the two rocks, and the very little apparent discrepancy in their position. Another case alluded to, is one where the Culm measures appear to pass downwards into Cambrian rocks; at which place, viewing the cliffs from the shore, it is no easy matter to define where the older strata cease and the younger begin. His conclusion is, "Now if this junction were not exposed in a bold "sea cliff, where the faces of these rocks are completely laid bare, how much might have "been written upon *conformability* and *passage*, and what erroneous inductions might have "been drawn from these fallacious appearances!" It appears, therefore, that rocks as new as the Coal measures have assumed the age and appearance of the Cambrian rocks, and that they cannot be distinguished without the most careful observations, even where there is the best possible exposure, that of a naked sea cliff. We need not be surprised, then, that rocks still older should, occasionally at least, appear in the same condition as those described by Mr. Murchison.

VIII. MINERAL PRODUCTS OF THE TACONIC SYSTEM.

Five important products are derived from the Taconic system: Brown hematitic iron, black oxide of manganese, roofing slate, the white and clouded marbles, and limestone. In addition to these, I might add flagging stone, which is of some consequence in districts not supplied with that material from the Helderberg range.

§ 1. Brown hematite, and oxide of manganese.

The brown hematite and oxide of manganese are associated in the same beds, and are derived from sources originally the same. I have already stated that the Stockbridge limestone often passes into thin talcose strata, in which a peculiar ferruginous looking substance abounds. These layers, by exposure to the atmosphere, become yellow from the presence of ochre which appears diffused through them. But they always disintegrate rapidly, and form deep yellow clays, which, on being penetrated, furnish nodules of oxide of iron; or, in places where there is a great accumulation, beds of the ore are found lying wholly disconnected with the rock in the common acceptation of the word. In some instances the ore is collected in beds in a fine drift, or soft material containing round pebbles, frequently granular quartz, and occasionally stockbridge limestone. It is difficult to determine whether the materials forming these beds have been transported or not. They appear to have been carried into depressions by the slow operation of common or ordinary causes, simultaneously with the disintegration and decomposition that detached and separated the particles from their common matrix. The beds thus formed may have been enveloped in drift, with the partial destruction of the accumulated materials.

The hematite embraces the usual varieties of imitative forms, as botryoidal, mammillary, stalactitic, etc. Large globular hollow masses are often met with in the excavations, of sufficient capacity to hold a barrel of water, and sometimes water is found in them. The interior of these large globes is lined with a splendent coating of manganesian matter, spread over the vertical fibres which terminate inwards. The outside is always rough with projecting points of hardened ore.

The manganese is usually collected in masses amidst the iron ore: it is in imperfectly compacted masses, or in that condition called *wad*. In other instances, it is in hard rough black masses, with a fine granular or earthy texture; and sometimes in fine needleform crystals of exceedingly high metallic lustre.

A range of beds of hematite extends from Westchester county, through Salisbury, Amenia, Stockbridge, Richmond, Bennington, and onwards to the Canada line. All the independent ranges of the Taconic rocks furnish beds of hematite.

Associated with the same beds is the gibbsite, an aluminous mineral occurring in the form of incrustations, and pendent among the masses of ore in stalactites or tuberous masses. Fine white clays also abound, which appear of the same composition as the gibbsite. White carbonate of iron is also quite common, usually in rounded or kidneyform masses.

The different minerals enumerated above are derived from the magnesian slates and limestones, and not from the taconic slate.

§ 2. Marbles.

The Stockbridge limestone furnishes by far the greatest amount of the native marbles used in the United States. The most esteemed is the clear white marble with translucent edges. It is not difficult to procure pieces which are faced, as it were, with this variety; but thick slabs, free from clouds, are rare. The larger proportion of the varieties appertains to the clouded kinds, which vary greatly in the patterns furnished by different beds.

It will be needless to furnish statistics of the trade in this material. The principal facts which I wish to speak of, are that the white and clouded marbles in our different markets are raised from beds in the Stockbridge limestone; that these beds are coëxtensive with the Taconic system; and hence, in a practical view, we are to search for these marbles along the general range of this system, and nearer to the great primary schists in New-York, Massachusetts and Vermont, than to the western border of the system.

Mr. Brown, the sculptor, now residing in Italy, tested the marble of some of the beds in the neighborhood of Middlebury (Vermont), for the purposes of statuary, and pronounced it very good; but in consequence of his removal soon after, its qualities have not been sufficiently investigated, or the quarries sufficiently exposed to determine their extent.

§ 3. Roofing slate.

The beds of roofing slate quarried at Hoosic and a few other places, were placed in the Hudson river series, notwithstanding they lie far towards the Hoosic mountain range. With this disposition I was never satisfied; but so strong was the determination, at the time I published my report, to consider all these slates and shales as metamorphic beds belonging to the New-York system, that I did not make up my mind to break away from the doctrine. I taught the same doctrine, too, in the spring of 1838, to my class in natural history in Williams College; but I was led the next year to abandon it, from the great difficulty of maintaining it against the light of some facts which had fallen under my observation.

In my first examinations of the slates of this region, I committed a serious error, in taking it for granted that all the beds near Troy belonged truly to the Hudson river shales. Accordingly I made that place my starting point, and examined carefully all the exposed rocks to the eastward, for the purpose of ascertaining the line of demarkation, if any existed, between these and the eastern slates. The error consisted in the first assumption; instead of which, the rocks near Troy, and lying adjacent to the great travelled road to the east, are composed chiefly of Taconic slate. The belt of the Hudson river series resting upon the Taconic slates, and extending north from near Chatham four-corners in Columbia county, terminates south of the road, which takes a circuitous route beyond the northern prolongation of the belt. Hence the reason why no change was observed; and hence, following a wrong direction, the beds of roofing slate were enabled to maintain themselves in a wrong position. My object is here to correct the error, into which I had fallen in spite of a feeble consciousness that I was all the time wrong.

Another position will also appear from this discussion; or if it does not appear, it is not the less true; namely, that the system in question has been studied by piecemeal, and the whole plan of it worked out of a continually increasing stock of facts from year to year; so that it has been built up from one staging to another, as materials were found to fit together. Now in this mode of building, we are very liable to place some of our materials with the wrong side uppermost, even if we do not arrange them wrong altogether. Hence one part of our business has been occasionally to pull down some of the superstructure, in order to readjust the pieces of which it was composed, and to discard or appropriate as was found conducive to its symmetry, and very likely further emendations will still be required.

Beds suitable for flagging occur in the Taconic slate, and in the thin beds associated with granular quartz. The former are highly calcareous: they are quarried in rhombic slabs, formed by the natural joints of the rock; they are very strong, exceeding the sandstones in firmness; and they are far superior to the limestones, as they usually come out without trimming. The quartz rock is also useful for flags, but its surfaces are harsher and rougher.

The attention of the public has not been sufficiently directed to the importance of the construction of good walks through the streets of our villages; and thus the stone not being called for, the quarries have rarely been opened.

A variety of the slate flagging has been discovered in Washington county. It is in a compact mass in slate, without joints, and is almost as difficult to break in one direction as another. When raised and sawed, it has the appearance of soapstone.

CONCLUSION.

The independence of the Taconic system is sustained or proved by the following facts:

1. *Position.* It rests unconformably upon primary schists, and passes beneath the New-York system, the oldest and inferior members of the latter being superimposed unconformably upon the Taconic slate.
2. *Dissimilarity of organic remains.* The *Nereites* and other fossils of the Taconic slate are unknown in any of the members of the Champlain group. In addition to which, it is important to bear in mind the fact, that in this group the mollusca of the New-York system are also wanting.
3. *The members of the Taconic system have a different arrangement.* The sandstones, limestones and slates are not only different in their relative position, but they are much thicker than those with which they have been supposed to be identical in the New-York system.

I leave it for future observers to determine whether the preceding positions have been sustained in this treatise or not; and inasmuch as it is now important that our palæozoic base should be determined by observation, it is to be hoped that the subject, with this special view, may receive the attention it deserves.

APPENDIX TO THE TACONIC SYSTEM.

THE origin of the brown hematitic iron has been a subject of considerable inquiry; but very little light has been obtained upon the subject, until recently. Formerly my own opinion in regard to its origin, was, that it originated in a limestone shale, which was charged partly with oxide and partly with a decomposing sulphuret of iron. Such a mixture exists throughout the entire range of the formation, and is usually a bed subordinate to the Stockbridge limestone; besides, the hematite occurs in beds connected with alluvial or diluvial formations, which appear to have been derived from decomposing or disintegrating masses situated at some distance. I am inclined to maintain the opinion still, that such may have been the origin of many of the beds situated upon the ranges of this system. During an examination, however, of some of these beds near North-Adams in Berkshire county (Massachusetts), I found that the ore might be traced to veins which penetrated into the solid quartz rock or brown sandstone of the Taconic system. This vein is interesting, in consequence of being connected with a peculiar brecciated mass, which consists of sharp angular fragments of quartz cemented by the hematite. The fragments are often enveloped in a layer of hematite of a fibrous structure, or, in other words, in a fine variety of limonite. This investing coat is sometimes half an inch thick, and it frequently cements masses of fragments of great size and weight. The opinion which has usually prevailed in regard to this breccia, is that the rock was broken thus by some cause unknown, and the fragments subsequently cemented together by infiltration of the oxide of iron. This mode of formation is not very objectionable, inasmuch as we frequently see operations of a similar kind now in progress. But we may very profitably inquire whether it is applicable to all cases; and whether, if we even admit it as true in part, we may not, under certain circumstances, adopt a different view of its origin? The first inquiry is, how came the quartz in this form, broken and even apparently comminuted, and the fragments as sharp and splintery as though they were just broken with a hammer? Pursuing our inquiries, may we not ask ourselves whether there is any connection between the force which broke the quartz as described, and that which effected the cementation subsequently? As to the Adams vein, in connection with the brecciated mass, the enquiry, taken in connection with the origin of veins, seemed very natural. Thus, adopting the view that veins are rents filled with molten or ignited matter, it appears highly probable that the oxide of iron or hematite might have been forced up from below; and, when it reached the surface, it may have flowed into the natural joints of the quartz rock, and have farther broken the bed by the sudden application of heat, and hence consolidated the fragments as we now find them. All the known facts which are at all concerned in the inquiry, go to show the probability of this view of the subject. Thus, heat applied suddenly to this vitreous quartz would have the effect we have supposed, namely, to fracture it: the filling of veins by molten matter from beneath, supports the same view, and in this case we see the hill of breccia and beneath the vein. It would be interesting, could we establish this view of the origin of this peculiar rock. This is quite apparent, when we take into consideration the multitude of these brecciated beds along the eastern limits of the Taconic system. They range nearly in a line running through Berkshire county, at the western base of the Green mountains, and northwardly into Vermont. The question will not fail to suggest itself to every inquisitive mind, whether these beds are all connected with veins beneath. The question of their origin then assumes a practical importance, and is worthy of being followed very carefully out to its full solution. If such a result should be obtained, it will open an inexhaustible source for this kind of ore, which is usually of an excellent quality, and easy to smelt. It is, however, proper to state, that the quartz rock in which this vein appears in Adams, is a hard rock to blast; and it is possible that the expenses, from this cause alone, of obtaining the ore, might be so great as to render these veins useless. Much undoubtedly would depend on their width : if wide enough to be quarried without rendering it necessary to blast the rock itself, then there would be no difficulty in working these veins. The matter must remain undecided, until some of them are opened and worked.

The position of the veins of limonite adjacent to the primary of the Green mountains, is analogous to those of Jefferson and St. Lawrence counties, where the specular iron, both in its earthy and crystalline state, appears in veins connected both with the primary below and the potsdam sandstone above. In both cases the veins are found only in thin parts of these sandstones, and near or adjacent to primary rocks. It is curious to observe, however, that in one case, the iron is in a state of peroxide pretty uniformly, forming the specular oxide, and I believe without exception ; and in the other, it is the hydrous peroxide, constituting the mineral called limonite. The former does not form a breccia with the potsdam sandstone, and we find a different association of minerals also in each of these cases. With the specular ore, we find serpentine, barytes, crystals of quartz, cacoxenite, etc.; and with the latter, gibbsite, allophane, manganese, and white carbonate of iron. The gibbsite and allophane are minerals of secondary formation, and, so far as observation has extended, they are not found in the veins of limonite. Distinct and irregular veins, however, of the latter mineral, are not new to mineralogists. Thus a few veins, a foot in width, traverse the gneiss of Dekalb in St. Lawrence county. The same occurs near Crownpoint, and indeed a thin vein has been found in the calciferous sandstone in Georgia (Vermont). A practical remark is suggested by the position of these veins, namely, that their place is near or adjacent to primary or igneous rocks ; or it is here that they are accessible, and reach the surface, though it may not be at all improbable that they are frequent in other situations, but concealed by a great thickness of sedimentary materials.

I take this opportunity to add a few additional remarks on the quartz rock itself. Some geologists of eminence have maintained that this rock belongs strictly to the Primary system ; that it is of the era and age of the gneiss, with which it is sometimes *apparently* interlaminated. This question, though I deem it to have been set at rest by my own observations in Maine at the Megunticook mountain in Camden, still as observations cannot make an obscure question too clear and certain, I am induced to add, that last summer (1845) I discovered beds of well characterized conglomerate at the base of this rock in Williamstown. This bed may be traced within a few yards of granite, upon which it evidently reposes. It is made up of pebbles (without any visible cement) of an oval shape, some of which are of the size of a hen's egg. They consist mostly of the quartzose part of granite or gneiss, rounded by attrition into smooth and well characterized pebbles, intermixed with fine mica, which sometimes adheres to their surfaces. This discovery, it must be admitted, settles the question as it regards the quartz, which is the most easterly mass of the Taconic system, or so far at least as to carry it out of what is termed in this country the Primary system, to which our gneiss and mica slate belongs; and it furthermore goes to show that the Stockbridge limestone, and some of the primary-looking slates also, belong to the same era as the quartz rock. In Maine, I observed a variety of mica slate or talcose slate, which contained well characterized chiastolite, resting upon this quartz rock, and it may probably prove that most of these macle rocks are of an age long posterior to the Gneiss and Mica slate systems.

There is another consideration which is deeply impressed upon my own mind, namely, that the line of demarkation between the Taconic and the Primary systems is clearly defined, especially upon the eastern side, where it was at one time supposed to be very obscure. Commencing then at the quartz rock in Williamstown, at the top of what is there called Oak hill, and ending at Troy, we pass over an uninterrupted succession of rocks belonging to the Taconic system. The distance, in a direct line, is about thirty miles from this bed of conglomerate. No primary appears on this route. On the more circuitous roads, however, we meet with beds of the calciferous sandstone, reposing unconformably upon the magnesian and taconic slate of the New-York system. At the junction of the quartz with the granite, the dip of the former is to the southwest, or perhaps to the south. The granite is rather peculiar, being a variety which contains a blue hyaline quartz; and it seems rather a persistent mass, inasmuch as it appears twenty-five and thirty miles to the north, in Arlington (Vermont), in precisely the same connection. It is, however, soon succeeded by gneiss to the east.

I have had occasion to speak of this granite before, and also of the termination of the quartz in this direction. All that I wish here to impress upon the reader, is the *affinity*, if I may use the expression, of those rocks which I have denominated *Taconic*, with themselves, or with each other; or rather the general coincidence in dip and strike, producing conformity with each other, and the non-coincidence or want of conformity with the Primary below and the New-York system above; proving conclusively the occurrence of an intermediate era or period of great length between the former and latter systems, during which another system (the Taconic) was deposited. This carries us back a vast stride in the earth's history, to the time when earthy sediments first began to accumulate or form deposits at the bottoms of seas; and by this we are informed that the earth had then cooled so much as to condense vapour, and to permit the fixation of fluids upon the surface. This condition, it is evident, was requisite before a single living creature, with organizations designed for the earth, could be sustained; and it is in this system that we find the first beings which had life and vitality, all of which, so far as discoveries have been made, were marine. We do not feel confident that it is in the earliest of these deposits that we have discovered fossils. Mr. JAMES HALL, however, informs me that he found the *Scholithus*, a tubular polyparian, in the most easterly mass of the granular quartz. On visiting the place as described to me, I was not successful in my search for this fossil; but at another locality, I found what appears to be an orthoceratite. The fossils, however, are more abundant in the newer rocks of this system; and they belong to beings of an extremely delicate construction, as the reader may see by reference to our description in another part of this report.

CHAPTER VI.

THE NEW-YORK SYSTEM.

GENERAL CONSIDERATIONS. CLASSIFCATION OF THE NEW-YORK ROCKS. I. CHAMPLAIN DIVISION : ITS RANGE AND EXTENT, PHYSICAL CHARACTERS OF THE COUNTRY OVER WHICH IT EXTENDS, AND AGRICULTURAL RELATIONS OF THE SAME. II. ONTARIO DIVISION : LITHOLOGICAL CHARACTERS, DISTRIBUTION, FRACTURES, etc.; SUMMARY. III. HELDERBERG DIVISION : LITHOLOGICAL CHARACTERS, INDIVIDUAL MEMBERS, FAULTS OR FRACTURES; SUMMARY. IV. ERIE DIVISION : LITHOLOGICAL CHARACTERS, INDIVIDUAL MEMBERS, FAULTS OR FRACTURES; SUMMARY. V. CATSKILL DIVISION : LITHOLOGICAL CHARACTERS, CHANGE IN FOSSILS, POSITION AND DISTRIBUTION; SUMMARY. CONCLUSION.

GENERAL VIEW OF THE NEW-YORK SYSTEM.

§ 1. Preliminary remarks.

I have now disposed of those rocks which I have denominated *Taconic :* rocks, which underlie that part of the State included between the Hudson river on the west, and the base of the Green mountains on the east. Their agricultural characters and relations will form the subject for a chapter in another place. I shall now proceed with the report on the plan I have already marked out, namely, that of bringing before my readers first those subjects which may be considered strictly geological; after which, we will be prepared to enter upon the consideration of the agricultural relations sustained by the several individual rocks, and the influences they exert upon the superincumbent soil.

The series of rocks immediately succeeding the Taconic, in the ascending order, constitute a full and distinct system in themselves, even if considered only within the geographical limits of New-York; and inasmuch as the series is complete, and they form by themselves one of those great and leading divisions of rocks, they have been brought under one head, which has been denominated the New-York System. Under the word *system* (p. 36), the reader will find what is to be understood by the term when geologically used. In New-York, the change between the period occupied in the formation of the Taconic rocks, and the commencement of the New-York system, is marked both by a change in the position of the former, and by a change in the character of the fossils of the latter. One of the most remarkable facts observed, is the introduction of the mollusca. I can speak merely from the authority of the observations which have been made up to this time. What may be discovered hereafter, we can not know; but it is right to draw inferences up to the present time: it is necessary only that we should keep ourselves ready to change, or alter our views with the progress of discovery.

The introduction of mollusca, then, begins with the New-York system: even at its base, the Potsdam sandstone, the *Lingula* abounds. In the previous system, plants and worms abounded; but it is worthy of observation that we have not yet discovered land plants, nor with certainty any terrestrial animals: all the organic bodies are marine.

The base, then, of the New-York system, is clearly marked; but the outgoing of it, the limits superiorly, are far more obscure. In this State, it is certainly not marked by remarkable changes in the sediments, or by powerful disturbance of former beds, in such a manner as to create unconformability between the newest members of the New-York and the oldest members of the succeeding systems, so as to cause the latter to repose unconformably upon the former. So in Wales,* the upper Ludlow rocks crop out from beneath the old red sandstone (Red system) conformably. The distinction, then, between the systems in both cases, rests upon diversity of organic remains. In order, however, that the foundation for the two systems should stand upon sufficient evidence, it is essential that those remains should be quite dissimilar in their types: such is found to be the case. In the Old Red system, fish possessing peculiar characters prevail; while most, if not all the mollusca of the New-York system, disappear. In New-York, however, there is a great want of fossils of any kind, except some obscure plants: the fish are confined to a thin mass; but time may bring to light a greater abundance of the peculiar forms of the Old Red system, by which it will be more perfectly identified with the same formation in Europe. We may recur to this subject again when I have reached the Old Red system: I therefore dismiss it for the present.

§ 2. Classification of the New-York Rocks.

The New-York system, then, comprising as it does a series of great thickness, and consisting of numerous members, it becomes important that we should adopt some mode of subdividing it. In doing this, I find that the divisions heretofore proposed meet all the necessities of the case; besides, they have been approved of by those who are acquainted with the New-York rocks, and hence I shall retain the division adopted in the reports. It is admitted that they are geographical; still they will be found useful geologically, as in each of the divisions we find rocks allied to each other, rather than to those in the other divisions.

The New-York system admits of four divisions, and it gives to each of these divisions the name of the particular region in which they are found. In the ascending order, the divisions stand as follows:

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* Murchison's Silurian System, p. 196, section 22.

1. The Champlain division, embracing as members,
   1. Potsdam sandstone.
   2. Calciferous sandstone.
   3. Chazy limestone.
   4. Birdseye limestone.
   5. Isle-Lamotte marble.
   6. Trenton limestone.
   7. Utica slate.
   8. Loraine shales, terminating in a gray sandstone, and sometimes a conglomerate which has been called Oneida conglomerate, and sometimes the Shawangunk grit.

These masses constitute the base of the New-York system; and though we may not regard the subsequent division with the same favor, this, to say the least, embraces a series of rocks, which, in natural history, would be considered as a natural series; or rather they may be looked upon as having been formed during a period,* in which the condition of the earth, as it regards heat and cold, and other circumstances which modify life, were quite uniform for the entire period they were being deposited. They might even constitute a system independent of the subsequent formations.

2. The Ontario division; the individual rocks of which are,
   1. Medina sandstone.
   2. Green shales, embracing one or two thin beds of oolitic iron ore; grits, coarse and fine, in alternating layers with the shales, some of which answer for flagging stone.
   3. Thin beds of limestone filled with the ***Pentamerus oblongus.***
   4. Niagara limestone.
   5. Red shale.
   6. Green calcareous shale, with a bed of limestone with cavities in the form of hoppers.

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* PERIODS.

What characterizes a geological period? If the reader casts his eye for a moment over the pages of history, what will he find? Something quite analogous to what is termed a period in geology. Take for example European history from the dark ages down to the present, will he not find certain events crowded into a distinct interval, which will characterize it from all others, and set it forth prominently to the gaze of the world? The period termed the ***Reformation*** is clearly such an one as will illustrate our meaning. But though distinct and prominent, it was not a sudden movement: it did not break out at once like a meteor, which comes forth from darkness and lights up the sky for a moment, and then as suddenly disappears — a something for which the world was wholly unprepared. Yet it had a beginning and an end. The historical period, if we scrutinize it, has its way prepared, and events are long shaping themselves that way; and when it actually commences, though it begins by some striking event, still that event is but one effect of what has already transpired: the world is prepared for it. As the burning of the papal bull by Luther in 1540, was, in one sense, the beginning of a period; yet was it foreshadowed by the past, and what had transpired rendered it, if we may use the expression, possible. So the geological periods never appear to have commenced by a sudden physical change in the condition of air, ocean or earth; nor in the great domain of life, either by a great and wide-spread destruction, or by a remarkable creation of wonderful forms. Still, when periods are compared, when the vestiges of one period are brought by the side of another, they are quite unlike, and yet are befitting the state and condition in which they appear; and as men are the actors in all historical periods, so nothing in the geological period appears but what might be expected from the agents then already in operation, excluding all traces of beings inconsistent with nature in any time or in any circumstances. He who looks upon the past periods as more remarkable than the present, takes a wrong view; and though it is clear that times and seasons have been for other beings than those of the present, yet the present is, if any thing, the most remarkable of all periods.

This important division may be farther subdivided into four groups: 1. Medina sandstone, consisting of hard and soft bands of rocks, sometimes suitable for flagging. 2. Green shales, oolitic iron, thin beds of limestone, and coarse and fine grits. 3. Niagara limestone. 4. Red and green calcareous shales, with the thin beds of limestone which together form the *Onondaga salt group.*

3. The Helderberg division, comprising,
   1. The Manlius waterlimes and thin shales.
   2. Pentamerus limestone.
   3. Delthyris shaly limestone.
   4. Encrinal limestone.
   5. Oriskany sandstone.
   6. Cauda-galli grit.
   7. Schoharie grit.
   8. Onondaga limestone.

It is difficult to subdivide this group by neutral planes, though the objection to consider it under the three following divisions are not very great: 1, the Waterlime group, embracing the thin and lowest beds, and the rocks up to the Oriskany sandstone; 2, the Sandstone group, embracing the Oriskany sandstone, Cauda-galli and Schoharie grits; 3, Onondaga limestone, including the Selenurus rock of Conrad.

4. The Erie division. It embraces the following rocks:
   1. Marcellus shales, terminating in a hydraulic dark-colored limestone.
   2. Shales and grits of great thickness, which have been denominated the Hamilton group.
   3. Shales and grits alternating in thin beds, which, taken together, have received the appellation of Chemung and Portage groups.

The upper beds are extremely deficient in limestone; only thin bands existing, which seem to have derived their origin from the fossil shells they embrace. This upper division, which is intended to extend to the Catskill or Old Red Sandstone, is distinct and correct so far as lithological characters are concerned, and may be undoubtedly subdivided by means of fossils. It embraces without doubt the *Devonian system* of Phillips; but as yet it is quite difficult, if not impossible, to say where this system begins. The change from the Marcellus shales upward to the Catskill rocks, is so gradual and imperceptible, that the outgoing of the Silurian or New-York system, and the incoming of the Devonian, never can be settled by geologists, except by conventionally agreeing where the one shall stop and the other begin.

5. The Catskill division, or the Old Red system. It is formed by the green and chocolate grits, and sometimes by a red marl, a material softer than a sandstone usually is. This division, although it has been denominated the Old Red sandstone, is made up of by far a greater amount of greenish-colored grits than of red ones. Beds of conglomerate also abound in different parts of the mass, but more conspicuously towards the top of the Catskill mountains.

I. CHAMPLAIN DIVISION.

Having given the grand divisions of the New-York system, we may proceed rapidly to the consideration of the individual members which compose them ; and in doing this, their agricultural relations appear to us the most important, and hence I propose to keep those relations in the foreground. In the Taconic system I had a special object in view, namely, its establishment, and therefore those characters and relations which are geological were mainly dwelt upon.

§ 1. Potsdam sandstone.

This sandstone is more uniform in its characters than most of the individual rocks in the series. At Potsdam, it is yellowish brown ; at Moira and its neighborhood, and also in Mooers, it is nearly white, and sandy ; at Chazy, it is of a deep red at the bottom, and gray towards the top ; while at Whitehall, Corinth, Hammond, and near Glensfalls, it is gray and more or less crystalline. In many places it is a coarse conglomerate, as at Mooers in Franklin county, and at Dekalb in St. Lawrence county. It is of course a siliceous rock, yet it does not exclude other substances or elements ; for, a true sandstone, far from being composed of pure siliceous sand, admits into its composition mica and felspar, oxide of iron, and probably even a greater variety of the primitive minerals, as hornblende, pyroxene, etc. in a state of fine division. This being the case, it does not necessarily make, on decomposition, a pure siliceous soil, or one free from alkaline matters : the mica and the felspar being decomposable minerals, especially the latter, we may expect to find traces of their elements in the soil. One way of determining the nature of the soil formed from this or any other sandstone, is to inspect it carefully with a common microscope, by which means we may discover the composition of the rock : the mica will be found in small glimmering scales, and the felspar in dull earthy grains destitute of the vitreous lustre. All grains possessing this lustre, or that of glass, may be considered as either silex or quartz.

This rock has suffered greatly by denudation. Being superimposed in New-York upon the Primary system, it has been exposed more directly, and for a longer period, to the action of those causes which destroy the solid strata, than have the subsequent ones ; and, besides, it has been exposed more directly in consequence of position. It has been first broken up on its interior rim, which rests on the primary, north of the Mohawk valley ; and hence, for this reason we find it more or less fissured or cleft, as well as distributed widely in boulders and fragments.

Its soil. The soil formed from this rock, is one possessing very distinctly the character of a granitic soil ; which, to be sure, is partly owing to the position it occupies, inasmuch as the debris of granite and gneiss must mix more or less with it.

How to distinguish the Potsdam sandstone. To distinguish this rock from other sandstones, its position must first be noted. Traced downwards, we are led directly to the primary mass, as gneiss and granite; traced upwards, we find it terminating in a sandy limestone. The exception to this rule is only found in the interposition of a mass of black siliceous slate, with obscure vegetable fossils, as at Whitehall and Chazy. The Medina sandstone, some parts of which resemble the Potsdam, is connected below with another gray sandstone, and above with green fragile shales. If any doubt exists, look for fossils. Of fossils, a single species, a lingula, is common at the High bridge at Keeseville, but small and obscure. At French creek, it is larger, but still obscure, in a sandy variety of the rock one and a half or two miles east of the village.

To learn the geographical position of this or any of the New-York rocks, study the map. It will be seen that this rock encircles very nearly the Great Primary region north of the Mohawk. Let it be observed, however, that it is wanting from near Fort-Ann in Washington county, south to the Highlands. It is also wanting in the valley of the Mohawk. When this is the case, the next rock, the Calciferous, rests upon the Primary, as at Little-falls, and numerous other places in the valley of the Hudson.

Before dismissing the Potsdam sandstone, it is necessary to call the attention of the reader to a variety of it which occasionally appears in Washington county. It is a tough black or brown mass beneath the calciferous, and varying in thickness from six or ten feet to more than one hundred feet. It is difficult to describe it: it is sometimes compact and irregularly striped, and unlike any other rock in the New-York system. It sometimes resembles hornstone, and breaks like it into irregular uncouth lumps with sharp angles: hence it is of no value as a flagging or building stone, except for the coarsest stone fences. This mass may be examined at Bald and Toby mountains: I have spoken of it as equivalent to Potsdam sandstone: it may probably with equal propriety be considered as a subordinate bed of the Calciferous sandstone, inasmuch as it is associated with it at the places just mentioned, and is not known to be associated with the potsdam. It is sufficient to consider it as an intermediate mass; but it is of no consequence, any farther than as it is necessary to be noticed to complete the description of the entire series.

§ 2. Calciferous sandstone.

Considered in its totality, this is one of the most heterogeneous rocks in the New-York system. That part which has furnished the name (meaning a sandstone bearing carbonate of lime, or a mixed rock consisting of siliceous or sandy particles and limestone), is well designated under the descriptive term, and is easily recognized. But there are several singular compounds embraced under this term; and without a brief notice of them, our descriptive geology would be incomplete. So heterogeneous is this rock, that Mr. Vanuxem, of the Second district, applied the term *Calciferous group.*

The typical rock under this name, is a gray mass with sparkling grains of lime, in which distinct masses of calcareous spar are always imbedded. It is an impure limestone, being mechanically intermixed with fine grains of quartz and slight interlaminations of argillaceous matter. In weathering, the lime dissolves, and leaves in relief the silex; and the thin interlaminations, which often course along the surface in undulating laminæ, are of a darker color than the body of the rock. In consequence of the tendency to weather, it presents a rough exterior when it has been long exposed; still it is susceptible of form, and as it splits into thick masses in consequence of being often thick-bedded, it becomes an excellent material for construction, and has been largely used for locks on the canals.

Another variety of this rock, is a fine-grained blue limestone nearly pure as a carbonate. Its peculiarity consists in the possession of two prominent characters, a compactness without lines of stratification, and an intermixture of white spar. Not unfrequently it appears as if the whole had been broken up, and then reconsolidated by means of white calcareous spar. The rock has not, however, been broken at all those places where these appearances occur. It is probable the appearance has arisen from the rapid formation of the rock, which, on drying, cracked by shrinkage, and into which cracks a pure calcareous matter has infiltrated. This mass is beneath the former: in fact it is the lowest or oldest of the deposites of this singular rock, resting directly upon the taconic or black slate.

Another mass which comes under the Calciferous rock, is still farther removed from the typical portion than the preceding. It is a red or chocolate-colored rock, consisting of sandstone slightly interlaminated with shale: it is not much unlike lithologically to some portions of the New Red sandstone. At Charlotte in Vermont, it is clearly a red sandstone; and considered only as a local mass, it would pass for the Potsdam sandstone; but inasmuch as at some other points it is above the blue limestone of the preceding paragraph, I have placed it in the Calciferous rock. Some portions are for a few feet a chocolate-colored slate; but in tracing it upwards, it is found to terminate in the gray calciferous sandstone by imperceptible changes.

This mass lies along the east shore of Lake Champlain. It does not appear in New-York, unless we regard that curious brown rock of Mount Toby as an equivalent. The vicinity of Burlington is the best region for forming an acquaintance with this mass.

One variety still remains, which requires at least a passing notice. This occupies a position above the last described: in fact, in tracing the chocolate sandstone upwards, we find it losing its color, and while becoming lighter, it shows an increase of carbonate of lime. It becomes, in the end, a fine-grained white limestone, sufficiently pure in many places for quicklime. Generally it contains silex or sand, and preserves a reddish tinge. In this condition it often resembles the Stockbridge limestone; though I have not observed it in that saccharoidal condition, it is always much finer grained than the Stockbridge limestone. But then again this variety passes into the ordinary calciferous sandstone, the gray variety first described: hence its relations, and the place where it belongs, need not be mistaken.

I have noticed already four varieties of the Calciferous sandstone, and at no single locality do they all appear. At St. Albans in Vermont, the blue, the brown and gray, may all be seen in juxtaposition in the order in which I have named them : in fact, at many places in the immediate neighborhood of St. Albans bay, the brown may be found passing into a whitish calcareous rock ; but it is no where so distinct as at and near Burlington and Addison (Vermont).

All the preceding varieties occupy the lowest part of the rock ; although, at the localities I have given, one or two of them constitute the whole of the mass.

Then again the Calciferous sandstone, when examined in its superior connections, is found quite as protean as in those masses which connect it with the Potsdam, or the Primary system, when the former is absent. For example, at Chazy, it furnishes a mass from 150 to 200 feet thick, composed of encrinal remains in fragments. I include, however, the fine oolite, and some subordinate beds which are highly charged with remarkable fossils. Some of these beds are sufficiently calcareous to form good quicklime, and even some of them are quite pure marbles of a reddish color. Subordinate to the whole rock, we may discover, at many points, beds of chert, and beds of large concretions or extremely coarse oolite, together with those masses which are commonly called waterlimes or hydraulic limes, and which may be known by their drab colors when weathered. This last mass might with propriety be reckoned as one of the principal varieties of the Calciferous sandstone.

The preceding may be recapitulated in the ascending order thus :

1. Blue compact limestone, and often sparry, but the planes of deposition obliterated.
2. Brown or chocolate sandstone, passing into both a fine white limestone and the ordinary gray sparkling limestone. Both varieties are confined to the east side of Lake Champlain.
3. The ordinary gray calciferous sandstone in thick beds. At the base of this variety, in the Mohawk and Champlain vallies, the drab colored or hydraulic limestone mostly occurs.
4. Superiorly are the important beds of encrinal limestone. Traces only of these beds occur in the Mohawk valley. Chazy is the only locality in New-York, where they exist in force.

Mineral contents. The minerals peculiar to this rock, belong mostly to the third variety ; and they all occur in irregular-shaped cavities, some of which are the size of a four-quart measure.

1. Limpid quartz, containing water and anthracite. At Middleville, Littlefalls, also thick beds of chert or flint.
2. Sulphuret of iron. Many places in the Mohawk valley.
3. Sulphate of barytes. Franklin county.
4. Calcareous spar, associated with the limpid quartz.
5. Sulphate of strontian, less common than the barytes.

Diversity in the composition of this rock. I have already noticed the most remarkable kinds of Calciferous sandstone. In the Mohawk valley, and also surrounding the great primary nucleus north of the valley, this rock is uniform in its composition, and easily recognized by its lithological character ; but those masses adjacent to the Champlain valley of the east side, are quite heterogeneous in their composition. This may be explained partly on the ground that the materials were derived from that remarkable system which lies adjacent to it upon the east. Some of the insulated masses upon this eastern range present us with a combination of products resembling the calciferous, birdseye and trenton; in which, too, the forms of the fossils are such that it is at first sight difficult to determine to which rock they are to be referred, a fact which fully corroborates the opinion that all the limestones of this group may be very properly included under one name. Even the *Bellerophon bilobatus*, which has been credited to the Trenton limestone, often occurs in the Calciferous sandstone.

A locality of this rock, in which there is a combination of the several limestones of the Champlain group, exists opposite to the city of Albany in Greenbush, crowning a remarkable knob near the site of the Old Cantonment; but in other places the line of distinction between the masses is quite evident, and from those localities one would infer that it is quite proper to keep up a distinction of the masses. In these instances, certain fossils are limited to the masses; and they often appear to be cut off suddenly, on some distinct change in the composition of the rocks.

Range and extent. The Calciferous sandstone covers a wider area than the Potsdam sandstone. It is, in the first place, coextensive with the potsdam; but in addition to this it passes through the Mohawk valley, where the latter is hardly known. In the counties of Dutchess and Orange, it forms an imperfect belt. In Columbia, Rensselaer and Washington counties, its continuity is still more broken. It occupies, in the three last counties, the knobs, as at Greenbush, Greenwich and Whitehall. These knobs lie contiguous to the valley of the Hudson: it is, however, still sparingly found twenty miles east of the Hudson river, as at Hoosic; and, as I now believe, near Pownal in Vermont, forming at the latter place heavy beds of siliceous limestone, which are peculiarly attractive by their bold broken outlines and perpendicular walls. Probably this broken range or belt runs obliquely across Columbia and Dutchess counties, and thence onwards through Orange, crossing the Hudson river a few miles above Newburgh.

We can hardly avoid the inference that this belt was once continuous, and formed an important mass, overlying the Taconic slate. At one period it undoubtedly was continuous with the same rock which passes through the Mohawk valley, and onwards to the northwest through Jefferson and St. Lawrence counties, and thence over wide tracts in the Canadas and the region of Lake Superior.

In the Hudson valley, the indications of its former extent are found in the insulated patches, which sometimes crown the highest knobs of the region; but then as the forces which occasioned the great northern fractures of this valley, disturbed and broke up the rocks unequally, we find it sometimes in the vallies outcropping from beneath the Hudson river slates, which have been preserved from denudation. These patches vary much in extent: some are limited to a few acres; others extend several miles, but they are quite insulated, and may be observed on all sides. At favorable points, the position they occupy need not be mistaken. They rest upon the slates of the Taconic system.

Before I pass to the consideration of the succeeding members of this group, I desire to call the attention of geologists to a narrow and irregular belt of the Calciferous sandstone which extends from Greenbush to the Canada line. It is apparently fragmentary, and is in some places undoubtedly so. It is fossiliferous, but most of the fossils are mere fragments, consisting of pieces of the crust of the *Illenus* and *Isotelus ;* but among these fragments, some small specimens of crustaceans may be seen, nearly perfect.

This mass is very liable to be confounded with the Sparry limestone, inasmuch as it is traversed by veins of calc-spar ; and where the soil conceals its borders, it is apparently interlaminated with the Taconic slate ; yet in many places it may be taken off from the upturned edges of the slate, and is absolutely and entirely removed from these where it has been quarried in several localities. This shows plainly, then, that it is a rock of another age, from the slates upon which it rests ; and as this rock is broken up, and as into it we find there has been introduced peculiar fossils, it shows that there was a change, a beginning of a new era, which we may with great propriety consider as the commencement of a new system.

§ 3. Chazy limestone.

Notwithstanding the remark that the lower limestones of the Champlain division may, with at least a show of propriety, be placed under one name ; still it is right, in our estimation, to designate certain masses under local names, where they are found in thick beds. This especially seems right in the case of this limestone, which exists in Clinton county, and whose entire thickness is at least one hundred and thirty feet. At Chazy, it is a dark durable limestone, more or less cherty and thick-bedded ; but so little disposed to split in any direction, that it is quarried with difficulty. This limestone is quite limited : it is best developed at Chazy, but still may be observed at Essex, where the characteristic fossil, the *Maclurea*, is quite abundant.

§ 4. Birdseye limestone.

This is the only perfectly compact limestone which occurs in the Champlain division. It breaks with a conchoidal fracture. The color is a light drab, passing into a dark blue. The light-colored variety has been pronounced a good lithographic stone. At Chazy, it is interlaminated with a few beds of fine granular siliceous limestone, similar to the hydraulic variety in the Calciferous sandstone. This variety is the most important for making quicklime ; for although it is often quite dark-colored, still it forms a remarkably pure white lime, and well adapted for glass-making, and for any of those arts where a pure lime is required. Such are some of the beds at Chazy. Some of the beds are singularly filled with calcareous spar : it often replaces the curious fossil hitherto known as the *Fucoides demissus*, but which (as will be seen by reference to my report) is strictly a polyparia. This is considered the characteristic fossil ; though near its junction with the next mass of limestone, several fossils allied to those in the Trenton limestone are somewhat abundant. The *Orthoceras multicameratus* is, however, equally characteristic with the *Fucoides demissus*.

§ 5. Isle-lamotte marble.

Reposing upon the birdseye, is a black finely granular limestone, called the *seven-foot tier* by the quarrymen at Watertown in Jefferson county, but which is better known in market as the *Isle-Lamotte marble*. At the latter place, it is twenty-five or thirty feet thick ; while at Watertown it is only seven or eight, and being at the same time lumpy, is unfit for marble, or any use except for the coarsest structures. At Glensfalls it is nearly as important as at Isle Lamotte. When present, it intervenes between the birdseye and trenton : into the latter it gradually passes. The fossils of the trenton are never, or very rarely found in it, and then only in the superior layers : neither do those of the birdseye pass upward into the Isle-Lamotte marble. It seems to be constituted of one or two thick beds, as if it had been deposited with great rapidity.

§ 6. Trenton limestone.

The Calciferous sandstone and the Trenton limestone constitute the two important limestones of this division ; inasmuch as they form continuous masses, and far more extensive than all the other limestones put together. It may be described under three varieties : 1, it is a rock made up of alternating layers of limestone and black slate, as at Chazy ; 2, of a thick mass of black limestone, as at Trenton falls ; 3, a gray limestone, sparkling from crystallization. These varieties sometimes exist together, and sometimes they are separated ; and, besides, where all are present, their relative position is not constant. At Montreal, the gray variety is the inferior mass ; at Watertown, it is the superior. But though there is irregularity in the position of the varieties, there is much constancy in the kind of fossils which belong to the rock. The upper part of the rock is a black calcareous slate, and passes by imperceptible gradations into the succeeding slate. Sometimes, the rock consists of alternating layers of black fine-grained slate : this is the case at Chazy, where it is between four and five hundred feet thick.

§ 7. Utica slate.

We propose to retain the divisions and names which were adopted in the Geological Reports, although some of them have but a slight claim to the distinction of independent rocks. This is the case with the Utica slate. It would do no violence to geological classification, to incorporate it with the slate of the Trenton limestone below, or with the Loraine shales above. It is an intermediate deposite ; or, in other words, a transitional formation, connecting the two ; on the one hand, it departs from the typical mass of the limestone, and becomes merged by gradual approximations with the Loraine shales. The fossils partake more of the character of the shales, than of the limestone.

This slate has no distinctive character in its composition, by which it may be known from any other slate, of a distant formation. It is only by position, and its fossils, that it can be recognized. Its fragile character is quite worthy of notice; as by its inability to withstand the combined action of water and frost, it is constantly passing into soil. This is especially the case if broken and raised from its beds. Under these circumstances, it forms an argillo-calcareous soil of the best character.

This mass is well developed in the valley of the Mohawk; but in the Champlain and Hudson, it is very imperfectly known. In the vicinity of Glensfalls and Sandyhill, it is easily recognized in its place above the Trenton limestone. It skirts the valley of the Hudson at Miller's falls; but in this range, especially upon the east side of the valley, it is concealed among the shales, and so much altered by pressure and other disturbances that it is by no means clearly defined. It may be studied in the gorges of Loraine in Jefferson county, where it may be seen in its inferior and superior connections. Its thickness is not less than seventy-five, nor over one hundred feet. In obtaining this estimate, I have been guided by the distribution of the *Triarthus beckii*, and the lithological character of the rock. There is less siliceous matter in the mass, which has received the appellation of Utica slate.

§ 8. Loraine shales.

The incorporation of the Utica slate with the shales of this section, may be well observed in the deep gorges of Jefferson and Lewis counties. A band of slate, quite fossiliferous, lies at the base of the shales, which is usually considered the superior part of the Utica slate. Within a few feet of this band, I have found the *Pterinea carinata*, which is one of the characteristic fossils of the shales. The shales are composed of alternating beds of slate in this mass in New-York, similar to the Utica slate, and thin siliceous beds, which become, in the superior portion, thick beds, with far less interposed shale. It forms, strictly speaking, thin and thick-bedded sandstones, of which the thick beds were deposited last.

The distribution of the fossils in this mass is worthy of notice. Proceeding from the fossiliferous band of the Utica slate, the fossils diminish rapidly, so that in the middle and inferior parts of the Loraine shales very few fossils exist; while at the upper portion the mass becomes highly charged with organic bodies, though distributed more abundantly through calcareous bands. But then they diminish again; and when the thick-bedded sandstone appears, they cease, with few exceptions. This peculiar distribution, and the confined limits of the fossiliferous beds, render the recognition of these shales, when they lie in proximity to the Taconic system, quite difficult; still, by careful examination for the thin fossiliferous bands, doubts may be usually removed. I say careful examination, for a careless observer would probably pass over some highly fossiliferous strata without recognizing them, in consequence of their obliteration outwardly; and it is only where the stratum is broken in the disturbed part of the formation, that they can be observed.

In describing this rock, it is hardly possible to separate the thick-bedded mass at the superior part, from the Loraine shales proper: there is a perfect transition of one into the other, and hence we can not say where one begins and the other ends. Still it is to be remembered that the thick-bedded mass is not always present: thus, near Utica, it seems to be replaced by the Oneida conglomerate. They are not to be regarded, however, as equivalent rocks, for both exist together in the valley of the Rondout in Ulster county. The thick beds may be observed in many places east of the High falls, exposed by the excavations along the Hudson and Delaware canal, and also by the main road leading up the valley. The mass may be observed to still better advantage at the northern outcropping along the termination of the Helderberg range, where it probably forms the thickest mass of any other locality in the State: it is here composed of alternating beds of sandstone and black slate, the latter varying in thickness from twelve to eighteen inches. The entire thickness of the mass here is not less than seven hundred feet. It has a slight dip only to the southwest, and is finely exposed from top to bottom by a small stream which flows over it near the roadside. It is here almost destitute of fossils, and in this respect resembles the beds which occur in patches upon the east side of the Hudson, along the Western railway. These latter beds may be clearly distinguished from the slates and shales of the Taconic system: they neither conform with them in dip, nor in strike; and except in the immediate vicinity of the great northern fracture of the Hudson valley, their dip and disturbance is not excessive.

This mass of slate and sandstone is almost worthless as a material for construction. Beds of the thick sandstone, in the course of a few years, break and fall into angular fragments; and even where they are defended in a great measure from the operation of atmospheric causes, they are very liable to crack. This may be seen on the Western railway, near Greenbush. The stones appear sound when first quarried, and so remain for a year or two, when they begin to show the influence of the weather. It is proper to state, however, that the disposition to crumble by the action of the weather, is less in Oneida and Oswego counties, where the same rock is quarried for grindstones: here the layers are quite regular, at least in some portions of the rock.

§ 9. Oneida conglomerate.

This rock is the newest member of the Champlain division, and, like some other deposits, is not continuous over wide areas. Its composition and character may be understood by those who are familiar with gravelly and sandy beaches, or pebbly beds, which, when indurated or consolidated, are perfect representatives of this mass. It is formed of rounded oval pebbles, small and large, intermixed with sand. Very little cement agglutinates the mass. Green chloritic matter is not uncommon in the body of the rock. It is firm; quite remarkably so, as it is often employed for millstones.

The Shawangunk range in Ulster county is composed of this rock, and the conglomerate near Utica belongs to the same formation. It is limited to those two ranges in New-York, and these are disconnected. The first is by far the most extensive and important. At Utica, it is a mass twenty or thirty feet thick, overlying and resting immediately upon the thin-bedded Loraine shales: the thick-bedded superior masses are wanting, though at Rome and its vicinity they are well developed, and appear even-grained and even-bedded, so much so as to be employed in the manufacture of grindstones.

This rock, at the Shawangunk range, is thick-bedded, and rises in mural escarpments of from thirty to two hundred feet. The position is often horizontal, but not always so, inasmuch as it is found dipping at a high angle to the southeast; and in other places, particularly upon the west side, to the northwest at a variable angle. In New-York, this rock extends from the New-Jersey line to Rosendale near Kingston, a distance of forty-three miles. The range is narrow, direct, and of a very uniform height, similar in this respect to the more southern ridges of Pennsylvania. The maximum thickness of the Onieda conglomerate of this range, is estimated by Mr. Mather at five hundred feet.

It is not well settled where this rock belongs, or in which of the two divisions it may be placed with the least violence to the rules of classification — whether in the Ontario division, or in the Champlain. This difficulty is created by the absence of fossils, excepting a few obscure casts of fucoidal stems. It may be regarded as an intercalated rock; as a landmark, indicating that a very important change has taken place, which marks the termination of one era, or the commencement of another. If we regard it as marking the termination of a period, it belongs to the Champlain division: if it is considered as the beginning of an era, it will belong to the Ontario division. Its importance as a way-mark is unaffected by either view of the case. Being made up of rolled stones and pebbles, it must have formed the shore of an ocean when it was consolidated; after which, it was elevated. Or, as some would regard it, it was formed as before stated of stones rounded by attrition; but they were brought together during a period of turmoil, which affected very materially the existing races of animals.

§ 10. General range and extent of the Champlain division.

If we separate clearly this lower division from the succeeding ones, we have mastered the geology of New-York. Nature has done this, and there is scarcely a locality where the rocks succeeding this division are so intermingled as to lead necessarily into error. We turn our attention first to the Mohawk valley, for in this we find a definite southern boundary. In this remark, however, we adopt what was the ancient boundary, rather than what appears to be its present limits, especially of the eastern part of it.

To obtain a point of departure, let the reader in imagination pass over the Schoharie stage road from Albany, but stop sixteen miles west. This part of the route is over the shales of the Hudson river, concealed mostly for the first ten or twelve miles by the tertiary clays and sands. The last mile, however, he ascends the northern terminus of the Helderberg range. The first part of the ascent is still Hudson river, and thus it continues until he has apparently reached the highest part of the mountain. A little to the left of the road on the westerly route, less than half a mile, the limestones of the Helderberg appear, occupying a position immediately upon the thick-bedded sandstone of the Hudson-river group.

If a tangent line, then, be drawn in the direction of Utica, so as to touch the Helderberg spurs as they come up from the south, this tangent line will form a very correct line of the boundary of this division. It may be carried on in the direction of Rome, and terminated upon Lake Ontario. South of this line there are no rocks belonging to the lowest division, except at the opening of the north and south vallies with the Mohawk. Thus, at Schoharie court-house, the Hudson-river rocks really underlie the clays and alluvions as high up as the bridge southwest of the village. So they may probably be traced a short distance up some other minor vallies lying parallel with this. They are all vallies of erosion, and the superior rocks have been removed, and hence the exposure of the lower ones in the bottom of these excavations.

We have, then, nothing more to do with the Champlain division in the whole of New-York south of this imaginary line : neither are the rocks superior to those upon the north side of it ; not a fragment in place, or even a boulder.

But here it is necessary to state, that on another route, we find the Champlain division largely developed. Departing from the eastern slope of the Helderberg range, and avoiding the higher spurs, we shall find the lower division continuing in the direction of Coeymans, Catskill, and onwards to Kingston, and thence to the High falls of the Rondout. The eastern side of this route is mostly the lower division. The only exception is at Becraft's mountain, near the city of Hudson, where the Helderberg rocks form an inconsiderable area : it is the only place where they appear east of the Hudson river.

The Hudson-river group stretches from the northern base of the Helderberg range, passing through Schenectady and onwards north of Ballston, and thence northeast towards Sandyhill. On the route of the canal from Schenectady to Albany, and at about four miles east of the former place, we meet the disturbed belt, where the shales and slates are curved, arched and broken, or form undulating planes for a great distance. These disturbances are well exposed along the route of the canal. Near the Cohoes, they may be examined ; and even here, although badly broken up, a faithful observer will find the fossiliferous bands. So a few miles west of Milton, opposite Poughkeepsie, the disturbed masses of the Hudson-river group disclose the fossiliferous beds. But in the slates of the Taconic system, though less broken and disturbed, we find no bands charged with mollusca. Those, therefore, who deny the existence of the Taconic system, should be able to account for and explain this fact ; and should this fact be sustained by continued observation, it is itself of sufficient importance to establish the position we have taken in regard to a system of rocks beneath and older than the Silurian or New-York system : it would mark clearly and ineffaceably a line of demarkation between the two systems we contend for. And should mollusca in the taconic rocks be discovered hereafter, it would not affect our position, unless indeed they were identical with those of some part of the superior system ; and even then how are we to explain the fact of superposition ? Now, the rocks below the

Potsdam sandstone are not extensions downward of repeated beds conformable thereto, but they are throughout non-conformable, of divers kinds, following each other in succession, and forming together an immense thickness far superior to all the rocks of the New-York system, embracing even all the masses up to the coal of Pennsylvania. For this reason, we say that those who maintain that the silurian rocks are merely altered rocks of the Champlain group, maintain that which is not far removed from an absurdity.

But to return to the consideration of the distribution of the Champlain group. I have already spoken of numerous insulated patches of some of these rocks. These are usually the Calciferous sandstone; and inasmuch as they frequently resemble the Sparry limestone, they are very liable to be mistaken for it, especially when they occur in the neighborhood of the latter. This mistake has been, and is still, very likely to be committed in the eastern towns of Rensselaer and Washington counties, where there are heavy beds of Calciferous sandstone with the fossils peculiar to the same.

I may call the attention of geologists to the limestones in Hoosic in the former county, where the *Maclurea* has been found by my friend Mr. L. Wilder. Generally those masses of limestone are not extensive; and even some are so limited, in which these fossils occur, that the entire mass has been removed, showing conclusively that they do not form a constituent part of the rocks upon which they rest; and moreover their dip and strike do not conform at all to the slates upon which they repose.

Another small range of the Hudson-river rocks occurs between Chatham centre and Chatham four-corners. The Great Western Railway passes over and through many of these thick-bedded masses, which are clearly the same kind of rocks as those which appear in the northern face of the Helderberg range. They lie in deep troughs; and as the thickness exposed in the railway cuttings are never deep, no lower rocks appear, but those which belong to the superior part of the Champlain group.

The superior rocks of the Champlain division border the west side of the Hudson, from Coeymans to New-Jersey. On this river, upon either shore, not a single member of any of the superior divisions exists. At Hudson city, on the western side, the Helderberg division forms the surface rocks over a limited area, but they are removed two and a half to three miles from its banks. At Coeymans, the same rocks are at least two miles west. At Kingston point, the Pentamerus rock is within about one mile, which is the nearest approach of this rock to the river.

The Shawangunk range, farther south, is a distinct western boundary of the Hudson-river group to the New-Jersey line; at least, neither the Ontario or Helderberg division appears on the east of this very remarkable range. The limit of these rocks, however, may be better understood by a direct reference to the accompanying map.

Important developments of the upper members of the Champlain division exist at the northern termination of the Mohawk valley, the valley of Oneida lake, and of Salmon river. It is interesting to notice some of the differences in these masses. At or near Rome, it is a tolerably clear gray sandstone, free from slate comparatively; and from its consoli-

PLATE II.

VIEW ON THE MOHAWK AT AMSTERDAM.

dated state, it is in a better condition for building, and architectural and economical purposes. In this direction, it is largely developed in Camden, Florence and Oswego, and still more largely in Mexico, New-Haven, Scriba, and Redfield. The most perfect exhibition of the gray sandstone mass is upon the Salmon river, where it appears in the three falls of the river, and the rock is exposed for more than one hundred feet. It disappears about two miles west of Oswego village, beneath the Medina sandstone.

§ 11. Physical character of the surface of the country underlaid by the Champlain group.

There is nothing very peculiar or striking in the region underlaid by the Champlain division. The surface is generally hilly, or rather undulating. The hills are not steep or rugged, neither are they bare of vegetation. The soil upon the limestone, and even upon the Potsdam sandstone, when thin, is not washed off in consequence of the steepness of the surfaces. All the rocks embraced in this division occupy comparatively a low level, not having been forced upward so as to reach mountain heights; and where they rest immediately upon the primary, they are merely broken up, but do not then form a rugged country.

In the annexed plate (Pl. 2) I have given a view of the scenery of these rocks, or rather a characteristic view of a large portion of the territory underlaid by them. It is perhaps more peculiar to the Mohawk valley, but it is intended also to convey a general idea of the vegetation of this region, which forms rather a contrast with that of the Genesee valley, as will appear on comparing the view at Amsterdam with that near Mount Auburn at Rochester. The peculiarity is seen in the difference existing in the growth of the elms: in the former valley, they are comparatively small, with pendulous branches; while in the latter, they are tall, with a straight trunk and a heavy overshadowing head. This is undoubtedly owing to the deep clays charged with the alkalies; and wherever we find those enormous but splendid elms, we may invariably see the indications of an excellent wheat soil.

§ 12. Agricultural relations of the Champlain division.

I do not propose to speak particularly of the soils of the district which I have named the Hudson-river district, and which in the main corresponds or belongs to this series of rocks. The first observation which strikes me as important, is that the soil is uniformly coarse. This is particularly the case with the shales and slates, which break up by the action of the weather into small angular pieces, and frequently fill the soil. The tendency, however, is to become finer by cultivation and stirring; but where the rock is near the surface, new layers are broken up as often as it is ploughed, and a supply is thus continually furnished. These pieces keep the soil open, which, without them, would in process of time become too compact. The limestones, except where they are shaly, are but little affected by the weather: hence but little calcareous matter is furnished by them to the soil. In this respect they are dissimilar to the primary and magnesian limestones, which crumble, and frequently form around their beds from twelve to twenty inches of comminuted calcareous earth. Another feature in the limestone, and even in the Potsdam sandstone, is its fissured state. The natural joints at the surface are opened widely, so as to admit the falling of large bodies into them; and into these cracks or fissures the surface water flows freely, and for this reason some portions of the country are liable to suffer from drought. But this is not all. Few if any springs issue from these rocks, except at a low level; and hence we find very frequently the waters which have been swallowed in the deep fissures, flowing out of the banks of some stream. The limited extent, however, of these fissured rocks, does not affect very materially the agricultural products: they are not barren in consequence of a want of water, as are some large limestone tracts in the State of Kentucky.

Upon the whole, the country underlaid by the Champlain division is favorable to agriculture. The slopes are rarely steep; the hills are susceptible of cultivation to their tops, and the disposition to produce grass of a sweet kind renders the fields and hillsides favorite grounds for the pasturage of flocks. The slates and shales are much less fissured than the limestones and sandstones; and, hence, from the impervious nature of their beds, they prevent the rapid escape of surface water. This holds good, whether the slates are horizontal or raised to a steep inclination; for, in the latter case, the laminæ are so powerfully pressed together, that if any thing they become more impervious than the undisturbed beds. However, where the rocks are horizontal, or even inclined, they always admit of an easy drainage; for ravines occur wherever there is a stream of running water, and these form general drains, into which artificial ones may be opened over the whole country where these rocks prevail.

§ 13. Springs which issue from the members of the Champlain division.

It is not possible always to determine the source of a spring, unless indeed the rock itself is sufficiently exposed to observation. A spring issuing immediately from the soil, may, previous to its exit, have traversed the rocky strata from a great depth; or it may only have percolated to an inconsiderable depth into the soil, and meeting an impervious stratum, it is soon forced again to the surface. If it passes through sand and gravel, it remains nearly pure; but if, on the contrary, it passes through shales or slates, charged with pyrites, with lime and saline matters, it dissolves a portion of them, and becomes in consequence what is termed a mineral spring. Its temperature too will suffer some change: if it percolates through fissures to a great depth, it will be raised. Every sixty feet,* in this country, will impart a degree of temperature. It may, however, lose a portion of its temperature in its upward passage. By far the greater number of springs issue from the earth at a temperature above the mean of the place.

The composition of the water of a spring is evidently affected by the strata through which

* This holds good only below the line of no variation.

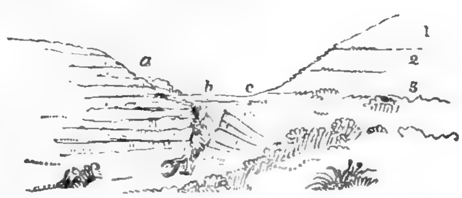
it passes. Those which merely pass through sandstone retain the purity almost of rain water; while those which pass through limestones are invariably impure, or *hard waters*, as they are termed. The water of the springs which issue from the Potsdam sandstone, is soft, or very rarely so highly charged that it will not wash well. The waters issuing from the slates of the Hudson river are more or less charged with saline matters; and what is worthy of remark, is, that they furnish many chalybeate and sulphur springs, or springs whose waters contain hydro-sulphurous acid in solution. They are mostly weak, and of but little medicinal value.

The most interesting and important springs, however, issue from the Calciferous sandstone. It is this rock, for instance, which gives origin to the celebrated Congress spring of Saratoga. This fact was proved two years since, when the spring was retubed. On carefully removing the deposit at the bottom of the spring, the water was found to issue from a small hole or fissure in this rock. It is of course impossible to trace the water farther; but this shows that it is not from the clay which fills the valley, nor from the Hudson-river rocks or slate of the Trenton limestone.

It is not my purpose to attempt to give a detailed account of the springs of this celebrated locality; inasmuch as in the report of Dr. Beck, all the most important facts are embodied, and may be consulted by the reader. Some independent observations, however, were made by myself in the summer of 1844, which may be found of some interest.

These springs issue from near a fracture in the lower rocks of the Champlain division. The geological structure of the valley may be understood by the annexed diagram:

Fig. 16.



a. Calciferous sandstone.
b. Birdseye limestone.
c. Trenton limestone.
F. Fracture.
1, 2, 3. Sand, yellow and blue clays, forming the eastern side of the valley.

Those who have informed themselves of the relative position of these rocks, will perceive that there is both a fracture and uplift. The calciferous sandstone, which occupies a position inferior to the birdseye and trenton, is at this place elevated above them. The fracture runs to the southeast, but the valley opens to the northeast. This fracture forms quite a depression, which runs nearly parallel with Broadway, the principal street of the village. We gain access to it at the south end of the street, near the site of Congress spring, where the rocks are less elevated. It is not proved, as I have already remarked, that any of the springs, except Congress spring, rise out of the calciferous; but from the fact of the existence of a fracture, we may infer with great propriety that they originate below the drift sand and clays of the valley; and as the slates are absent, or distant two miles at least, we may also infer that the waters do not originate in them, but probably are connected with or rise out of the fault or fracture which has been already described. I made many careful observations on the temperature of all these springs, which I deem proper to insert in this place.

The temperature of	Congress spring was	50°	Depth 12 feet.
	Washington ..	49	.. 22
	Hamilton ..	49	.. 16
	Putnam ..	49	.. 20
	Pavilion ..	48½	.. 38
	Flatrock ..	50	.. 14
	Highrock ..	51½	.. 8
	Iodine ..	50	.. 7

The Pavilion spring constantly overflows, and resembles a boiling fountain, from the rapid rise and escape of carbonic acid. Putnam spring rises out of sand. Washington spring rises out of a blue clay and pebbles: this is ferruginous.

One mile northeast from the springs whose temperatures I have just given, are ten other springs, whose general character is the same. The temperature is as follows:

Brook spring	51°
Union ..	51
Jackson ..	56
Twins ..	58

The five remaining springs are too much exposed, and open to the incursion of rain-water, so that observations are of no consequence. The Union spring is equal to the Congress for drinking. Jackson and the Twins are much exposed to variation of temperature, in consequence of their unprotected state. These ten springs are in a deeper part of the valley, which is filled with blue clay that has been bored into to the depth of eighty feet without reaching its bottom; still it is not improbable that all these springs are directly connected with fractures of the upper cluster of springs, but issue from it at certain points which prevent their reaching the surface immediately.

In addition to the springs already noticed, there are two others of fresh water situated a little to the west of the main valley, whose temperatures are 49°; and a well near by, with temperature of 48°: these are shaded and protected from the direct influence of external heat. Good water, in this neighborhood, is readily obtained by wells at the depth only of sixteen or eighteen feet.

An interesting fact which can not escape the notice of the most careless observer, is, that these springs, though situated very near each other, and probably having one common origin, yet differ very materially in composition. Perhaps it may be said that this very difference disproves the assumption of their common origin. It may be so: still the circumstances, upon the whole, go to prove that they are connected with the fault; and if so, the assumption does not militate against any fact or principle.

Before I pass to the consideration of another subject, it seems proper to state that this fault probably forms the most western limit of that disturbed district so often referred to in these reports, and which occupies the whole of the territory between the Hudson river and the Green mountains. The rocks, it is true, are inclined as they approach the primary: still their dip is much less than towards the Hudson river. Not far from Schenectady, the slates and shales of the Hudson river are horizontal; but three or four miles east upon the canal, they are greatly disturbed. Draw a line then north or a little east of north from Schenectady to Saratoga-springs, and then onwards to Baker's falls on the Hudson, and it will pass near the line of fracture, where, upon the west side, the rocks are but slightly inclined, and on the other they dip precipitously to the east, and in this state underlie an immense extent of territory. This fault appears to be quite similar to that at the falls of Montmorenci in Lower Canada.

The disturbed district does not end or terminate, as has been described by Mr. Rogers, by a gradual opening of the curves of dip; but the dips continue with very little variation to the very line or place where they terminate abruptly in horizontal strata, and with a simple fault or fracture. This is the fact throughout the whole extent of New-York. It may be observed at numerous places along the Hudson valley, as at Coeymans, Coxsackie, and Kingston. Still there are numerous inverted curves, and undoubtedly many points where the phenomena indicate lateral pressure. Indeed it seems impossible that the strata under consideration could have been fractured and broken without this lateral pressure, which would produce very frequently curves and arches of various kinds.

§ 14. Fractures and dislocations of the rocks belonging to the Champlain division.

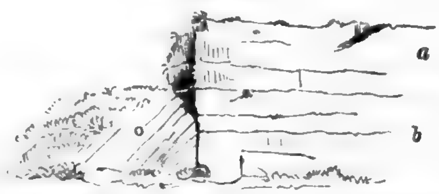
It is frequently impossible to determine the era of any given fracture, for the reason that the series of rocks may be incomplete and deficient. It is notwithstanding well determined that the consolidated sediments have been fractured or broken, and also that this has taken place at certain periods, though it is not pretended that these intervals were regular; that is, that disturbances have prevailed and continued during certain periods, when they have ceased, and the territory has remained in a quiescent state for an indefinite time. In one word, it is supposed and maintained that changes of the kind which are under consideration, have been paroxysmal. A feature which is very common in faults and fractures of strata, is the nearly linear direction they pursue: in this feature they are analogous to dykes, which may often be traced forty or fifty miles in a continuous route.

Two other facts render the subject of faults interesting and important. It is not uncommon that they have been made the repositories of valuable ores, when they become in fact metallic veins; and, again, from them issue some of the most important mineral springs. For these reasons, I propose to notice some of the faults and fractures which traverse the strata composing the Champlain group.

Commencing, then, with the lowest member, the Potsdam sandstone, we find this rock traversed by irregular fractures adjacent to or near the line of contact between it and the Primary rocks. The only ones, however, which I propose to notice, are now in the form of deep gorges, one of which gives passage through it to the Ausable river at Birmingham in Clinton county; and the other is in the town of Mooers, in the vicinity of the Provincial line, or indeed it is stated that this line passes through the gorge. In both of these instances, the displacement of the strata is only slight, just sufficient to break their continuity. As has been remarked, they are deep gorges, varying in depth from twenty-five to one hundred and fifty feet. A particular account is given of them in my report of 1842. These gorges do not appear to be connected with metallic or any other veins of mineral matter. They were formed, in the first place, by a slight upheaving, which served to crush or break the strata, forming a line of fracture; afterwards this broken line became a water course, and the movement of water through it was sufficient to clear out and widen the breach already produced.

A more interesting and important fault or fracture, however, traverses the State from south to north, and involves in its derangements not only the lower rocks, but some of the Helderberg series. I can only indicate some of the points where it may be observed. One mile south of Kingston, the thick-bedded sandstones of the Hudson-river series are elevated and raised up to the base of the Pentamerus limerock. The dip of the former is to the east at an angle of 30°, with their edges resting against the horizontal beds of the pentamerus and the upper part of the Waterlime series. The exposure at this point is one of the best, in consequence of a cut through both series of rocks, whereby the relations of the masses are satisfactorily revealed. Apparently there is here an unconformity of the Hudson river series with the waterlimes which immediately succeed them: this unconformity, however, is produced by the disturbance of a portion of these rocks only, the conformity remaining with the masses which are undisturbed. Fig. 17 represents the position of the rock at the locality specified, which, to be more particular, is about one mile from Kingston point, at a place where the rock is extensively quarried for cement.

Fig. 17.



a. Pentamerus limestone. *b*. Waterlimes. *c*. Thick-bedded gray sandstone of the Hudson-river series.

We may trace this same fracture north to Saugerties, four miles west of Catskill, and through Coxsackie, New-Baltimore and Coeymans. At New-Baltimore and Coeymans, we may see disturbances of the same kind as those at Kingston point, with the easterly dip of the Hudson-river series, which terminates at once with the waterlimes and pentamerus, the latter retaining their horizontal position. At Catskill, the fracture passes through the Delthyris shales, or affects the whole of the Helderberg division. From Coeymans, this

PLATE IV.

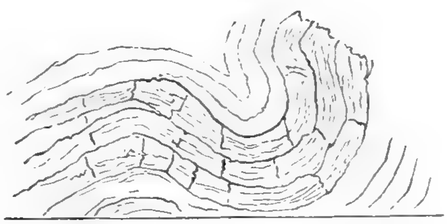
E. EMMONS JR. DEL. ENDICOTT'S LITH. N. YORK.

THE PENTAMERUS ROCK,
on Cattskill Creek.

fracture changes its direction, and makes its way to the valley of the Mohawk. It is only two miles from the river at Coeymans; but when it has passed so far as to be directly west of Albany, it is twelve miles distant. This point is near the route of the Cherryvalley turnpike, where it commences its ascent over the north end of the Helderberg range, which route is mostly over the Hudson-river series. From Albany to near the foot of the mountain, these rocks are steeply inclined to the east and southeast; while on the route over it, they have the common inclination to the southwest of the upper New-York rocks, which does not differ much from thirty to forty feet to the mile.

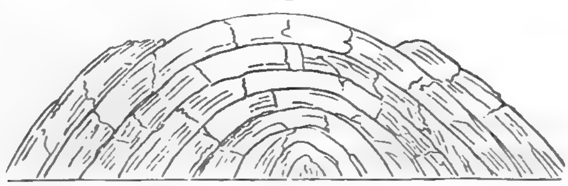
This fracture sends a branch north, which passes east of Schenectady. At Saratoga, its western limit, as already stated, is Saratoga-springs, where it bounds on the west the valley of the springs, and where the calciferous is the lowest rock which is exposed, and which remains nearly horizontal, while the trenton appears on a lower level, as if it had been affected by a down-heave. See fig. 16, p. 131.

Fig. 18.



In this line of fracture, it is interesting to observe the modifications or changes which the strata have suffered at different points. I therefore give two additional illustrations: the first (fig. 18) is taken from the rocks four miles east of Schenectady, upon the line of the canal. It exhibits contortions which the strata have undergone by the force of lateral pressure. It shows only segments of the curves, one of which rises and forms a high arch in the mural procession, while the other projects down beneath the surface. The other (fig. 19) is taken from the line of railroad, two and a half miles west of Catskill. It is a massive inverted arch in the thick-bedded sandstone of the Hudson-river series. A great variety of contorted strata may be observed in the course of a mile on this road, of a highly interesting character. These, however, are sufficient to show the character of the disturbances to which this belt of rocks has been subjected.

Fig. 19.

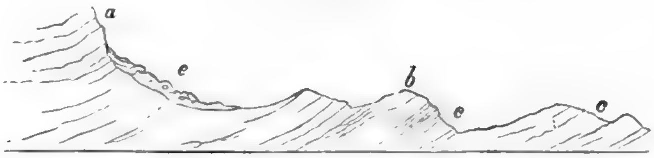


Another great line of fault exists upon the eastern side of the Hudson and Champlain vallies: it in fact has elevated the country in such a manner that the line of fracture bounds the valley. The most conspicuous eminences are near this line, and the rocks are the slates of the Taconic system, surmounted by one or more varieties of the Calciferous sandstone. Greenbush, Baldmountain, Granville, Whitehall, Addison, Burlington, Milton, are upon this line of fracture, and I might mention many other intermediate points where all the phenomena I have stated may be witnessed.

The agent which determined the existence and direction of this great longitudinal displacement of the strata, gave origin also to the vallies of the Hudson river and Lake Champlain; or, it may be more properly said, that the boundaries were first determined by it, and that then the vallies themselves were formed by denudation. The entire series of sedimentary rocks, which have been elevated and thrown into an inclined position, lie between the base of the Helderberg and the Hoosic mountains. But in taking so wide an area as this, we undoubtedly embrace fractures more ancient than the one which forms the valley of the Hudson. This, though it disturbs the Hudson-river rocks mostly, yet in one section of country it passes through a prolongation of the Helderberg division; showing, in this fact, that it was really of a date as late as the Onondaga limestone. But the Taconic rocks were elevated, and made to assume an inclined position, before the deposition of the oldest member of the New-York system: this follows from the unconformability of the two systems; but it is impossible to fix upon the era. The Taconic rocks rarely occur superimposed upon one another, as we see in the arrangement of the Helderberg division, and in the slates and shales above; and hence, it is, that though they may have been fractured many times between the deposition of the granular quartz and the taconic slate, still the relative position of the masses is such that no rational conclusions can be formed in regard to the era in which they took place, whether in the earliest or latest period of the system.

Another limited fracture appears on the southeastern side of Becraft's mountain, about three miles southeast of Hudson. On one side the Taconic slate appears supporting a fragmentary mass of the Calciferous sandstone; on the other, the inferior members of the Helderberg division, the thin-bedded waterlimes and pentamerus, beneath which are the gray sandstones of the Hudson river. The relation of the latter mass is illustrated in fig. 20.

Fig. 20.



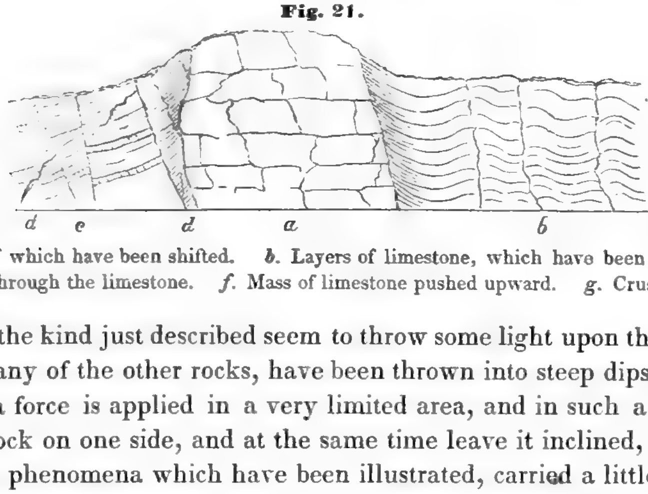
a. Pentamerus limestone. *e.* Talus. *b.* Thin-bedded waterlimes. *c, c.* Hudson-river series.

Another instance of a fracture, apparently more limited and local, occurs at Essex. This fracture is fully illustrated and explained in my report of 1842. It is, however, so interesting, that I subjoin a figure, with an additional explanation of its features.

The first and most prominent character of this uplift is the upward thrust of a thick mass of the Chazy limestone through the Trenton limestone and Utica slate, the former of which is adjacent and upon the south side. At the line of junction of the slate, it is crushed and bent upward. The same effect has taken place upon the north side also. The mass thus elevated is not less than eighty rods in width (fig. 21).

Another change that has taken place, and which seems to stand connected with this uplift, is the short fracture, first in the slate south, and next in a portion of the mass which has been elevated. In the former, however, the change consists in shifts of the strata, as where a particular calcareous layer is broken several times, and moved out of its original place. On the other side, the thick strata of limestone are fractured, and, at each fracture, the ends are bent, as at *b*, which may be considered either as an oscillation, or as the effect of an upward moving force acting upon very limited portions of the rock, for the broken masses are only about ten feet long.

Fig. 21.



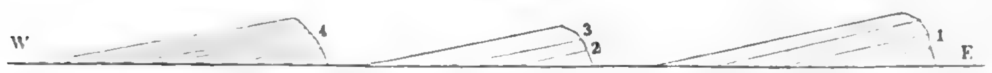
a. Slate, the layers of which have been shifted. *b.* Layers of limestone, which have been moved by oscillation. *d.* Dyke passing through the limestone. *f.* Mass of limestone pushed upward. *g.* Crushed strata of slate.

Phenomena of the kind just described seem to throw some light upon the mode by which the slates, and many of the other rocks, have been thrown into steep dips over wide areas. If, for instance, a force is applied in a very limited area, and in such a way as to break and elevate the rock on one side, and at the same time leave it inclined, it would be only an instance of the phenomena which have been illustrated, carried a little farther; and in order to have a wide area underlaid with steeply dipping rocks, it is only necessary that the process should be repeated. We may indeed suppose that the first application of a force breaks the strata as represented in the diagram; and, afterwards, a repetition of the same force, would probably result in giving an inclined position to the masses. In support of this view of the subject, I may refer to the changes of an analogous kind which have resulted in displacing the same rocks in the valley of the Mohawk. Thus, at Tribe's hill, by the side of the railroad, three uplifts occur at short intervals, as has been shown by Mr. Vanuxem. His diagram is annexed,* by which it will be observed that the strata are not

* Vanuxem's Report, p. 205.

only broken at quite regular intervals, but have been made to assume an inclined position. They only require to be uplifted a little more, in order to resemble the strata upon the eastern side of the Hudson river.

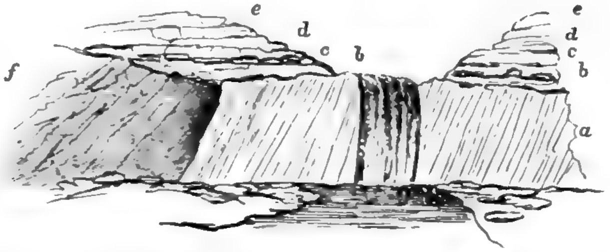
Fig. 22.



1, is the Calciferous group. 2, consists of the Birdseye limestone. 3 & 4, Trenton limestone. The dip is 10° south.

Many other instances might be given, illustrating and supporting the same views, both in the Champlain and Mohawk valleys; and it is perhaps proper to remark, that it is principally in these valleys, and other parts of the State adjacent to the Primary system, that the changes of the kind I am describing are found: they are scarcely, if at all, to be found at only a short remove from these ancient rocks.

Fig. 23.



The falls of Montmorenci exhibit an interesting view of the rocks, resembling the fracture which has been already described. It is upon the western limit of this line of fracture. *a*, *b*, *c*, *d*, Utica slate, Trenton limestone, Calciferous and Potsdam sandstone, in a horizontal position. *f*. Utica slate thrown down so as to dip at an angle of 60 or 70°, and leaning against the gneiss that forms the precipice over which the water is precipitated.

§ 15. Thickness of the rocks of the Champlain division.

The following is the best estimate of the thickness of the individual members of this division, that I have been able to make: it of course applies only to these rocks as they exist in the State of New-York.

1. Potsdam sandstone	300 feet.
2. Calciferous sandstone	400
3. Chazy limestone	150
4. Birdseye limestone	50
5. Isle-Lamotte marble	25
6. Trenton limestone	400
7. Utica slate	100
8. Shales and gray sandstone	700
9. Oneida conglomerate	400
Total thickness	2525 feet.

The above estimate is offered as the maximum thickness of the rocks in New-York. It must, however, be taken in connection with the fact that many of them are much thinner; and if they occurred only with the thickness which they attain in a few localities, they would not be regarded as distinct rocks, but as subordinate layers in other and more important beds. Thus the Oneida conglomerate is about thirty feet thick in Oneida county; but in Ulster, it is between four and five hundred. The birdseye, which is always, however, a thin rock, is only one or two feet thick at Tribe's hill; while at Chazy, it is at least fifty feet. The calciferous also varies greatly: several important and interesting beds are wanting in the valley of the Mohawk, which exist in great force near Chazy. The Potsdam sandstone is wanting at Littlefalls, but is probably more than four hundred feet thick in Mooers in Clinton county, and in fact all along the Provincial line.

There are, therefore, two very curious features exhibited in the Champlain division: the great irregularity in the thickness of the rocks composing it, and the suddenness with which this change seems to have taken place. Still, in order to form an approximate idea of the length of the era during which these rocks were being deposited, it is necessary to ascertain the maximum thickness of the whole series. It is not probable, however, that even the whole age of the Champlain division can be determined in New-York. If we find individual members thicker and better developed in Pennsylvania, it is evident that something must be added to the age of this division: the era, in other words, will be proportionally lengthened.

§ 16. The relation and connection of the Champlain division with the succeeding rocks in the ascending order.

The connection of the Champlain division with the rocks which succeed it in New-York, is quite interesting as well as important. On the western and eastern sides of the Hudson river, the upper members are succeeded immediately by the thin-bedded limestone and shales of the hydraulic limestone of the Helderberg division. This is also the fact at the northern terminus of the Helderberg range; so also at Schoharie village, and as far west as Cherryvalley. Near Utica, however, the upper rocks of which I am speaking, or those of the Hudson-river group, are succeeded by the upper members of the Ontario division, or the Clinton group; while at Oswego, they are succeeded by the Medina sandstone, the lowest member of this division.

From these facts, it is inferred, that at the close of the period to which the Champlain division belongs, the surface, or the rocks themselves, were subjected to oscillations, and to movements which were more remarkable than those which occurred during the period of their deposition. It must be admitted, however, that the intervals between these movements were rather wide, inasmuch as rocks of considerable thickness were sometimes deposited between them. These facts, however, indicate that the close of this period was one of considerable consequence; and that we should probably be justified in considering the Champlain division rather as a system by itself, than as a subordinate division of the

New-York system. This view appears to be supported by facts of another kind, and, if any thing, of greater importance than those which belong to physical changes of surface. The fossils, for instance, belonging to this subordinate division as it now stands, do not exist in the succeeding rocks. Even where the Medina sandstone succeeds the Gray sandstone of Oneida county, the fossils are not carried up. In fact, the entire fauna of the Champlain rocks became extinct at the close of the period during which they were deposited. From these facts, then, this division must be regarded rather in the light of a system, as we have just observed; inasmuch as it is made up of a series whose characters are peculiar, and which do not belong to the preceding or succeeding era. It is true that the fossils of the succeeding rocks do not differ widely from those of the Champlain division: many genera continue, though all do not; yet it is worthy of remark, that those which disappear are quite limited in their ranges both vertically and horizontally. The genera *Orthis*, *Atrypa*, *Strophomena*, are continued; but the crustaceans, as the *Isotelus*, *Illenus*, with some others, are not found after this period.

§ 17. Recapitulation and summary of facts relating to the Champlain division.

1. The Champlain division is conformable to the succeeding divisions; but as its members are placed upon the outside, and form a belt, consisting of a series of rocks adjacent to the primary, they are more disturbed and broken than those of the succeeding divisions.
2. The inferior rock of this division, the Potsdam sandstone, is in the greatest force upon the western borders of Lake Champlain and the northern boundary of the State, nearly encircling the primary nucleus of Northern New-York; but in some places it is absent on the south side of this nucleus, as in the Mohawk valley. In this case, the next superior rock, the Calciferous sandstone, forms the base of the division, and reposes upon the primary.
3. The division embraces lithologically all forms of rocky strata: Conglomerates, breccia, sandstones, limestones, calcareous and sandy shales, and slate. Sandstones generally form the base (but there are two locations where it is a conglomerate), and the summit of the division: the former are red or brown; the latter, gray. The limestones occupy the inferior and middle portions of the series, and may be justly described under one name in a general system.
4. The principal depositories of metallic bodies are at the base of the system, where the peroxide of iron has been forced upward from the primary, and hence occasionally occupies some of the inferior layers of the Potsdam sandstone. Galena and sulphuret of iron form veins in the limestone, but they are not important.
5. Agriculturally the most important masses are the limestones or calcareous shales, all of which decompose and form a rich and valuable soil. Water and frost greatly facilitate the process; and masses of these shales, when thrown into heaps, speedily break and crumble into a dark argillaceous earth.

6. The lower limestones of this series give origin to the celebrated springs of Saratoga county, where they issue from a fault. The shales of the Hudson river give origin to many weak hepatic springs, or those whose waters are charged with sulphuretted hydrogen. The sandstones give origin to waters comparatively pure. Faults and fractures, and undulations of the strata, are not uncommon. Of the latter kind of displacements, the Mohawk valley furnishes several good examples: thus, at or near Fultonville, the Utica slate at one time appears in the banks at the level of the canal; at the same level, and farther on, the trenton and even the birdseye are brought up so as to occupy the same plane as the the Utica slate. This fact should not be lost sight of, in estimating the thickness of rocks by the amount of dip, when they are concealed beneath the soil.
7. The rocks which are useful for construction, are the Potsdam sandstone, Calciferous sandstone, and the gray sandstone of Oneida and Oswego counties. The Isle Lamotte limestone, which is the same as that at Glensfalls, furnishes a fine black marble.
8. The peculiarities in the characters of the organic remains, are, that the species are not numerous, but the individuals are, and they occupy extremely limited ranges both vertically and horizontally: some in fact occupy but a few strata of only two or three feet in thickness.
9. This series, when considered in its totality, is well entitled to the appellation of a system: its thickness and its fossils both support and sustain this view. This view, however, is founded upon a comparison of this series with others which constitute divisions of a similar kind in this country and in Europe, as the Devonian, Old Red, Permian, &c.

II. ONTARIO DIVISION.

Geographically this division of the New-York rocks is very clearly defined. It appears in characteristic masses only on the south of Lake Ontario. It embraces, however, rocks which are somewhat diverse in character, and hence it will be necessary to consider them under separate and distinct parts or subdivisions. The individual members are given on page 115, with the subordinate divisions proposed, and which in the ascending order stand thus:

1. Medina sandstone.
2. Green shales, grits and limestones, composing the Clinton group.
3. Gypseous rocks, or the Onondaga-salt group, with the red shale reposing upon the Niagara limestone.

§ 1. Medina sandstone.

This rock, as its name indicates, is a sandstone, taken as a whole; but when examined in some places, it bears but a slight resemblance to a rock of this kind, though at these locations it has undergone an important change from atmospheric influences. Thus, on the Niagara river, it is a soft marly rock, cracked and broken, or ready to break into short columnar masses, which in their turn are still farther changed, and which finally pass into an argillaceous paste, or an argillaceous soil when dry. That this is the effect of weathering, appears from the fact, that where the deeper parts are exposed, it is a sandstone, which retains its original characters for a time, but finally disintegrates, and becomes in process of time a soil, as has been stated.

The Medina sandstone is a red rock, or else is red and mottled with green. It is never a white sandstone for any considerable distance, but retains a tinge of red. Some parts are harder than others; and, when viewed in this light, it may be divided into the following kinds: 1. The inferior mass, which is a soft and mottled sandstone, which may, by exposure to the weather, become still softer. 2. A hard sandstone, suitable for flagging, and, as such, is extensively quarried at Lockport. 3. A still harder sandstone, possessing somewhat the characters of a conglomerate: it is lighter colored than either of the preceding. The soft inferior sandstone is repeated, and lies upon the thin-bedded flagging stone of Lockport.

Extent and distribution. This rock, which is colored brown upon the Geological Map, extends from Oswego to Niagara river, in a narrow belt upon its south shore. It has been extensively denuded, but is notwithstanding a well defined rock. It rises but a few feet upon an average above the surface, through this entire route; and hence, where exposed, it is not in mural or elevated escarpments, but in deep ravines which have been cut in the rock by running water. The harder parts have resisted this force for a time, and perhaps have formed falls and cascades. The deep gorges of the Genesee and Niagara rivers are the most important and interesting places for examination. But it is advisable that the localities where this rock appears, and where it may be examined, should be more distinctly described.

The rock, then, appears first in the northeastern part of Redfield, in Oswego county. It there forms a thin stratum in the most elevated part of the town, reposing directly upon the grey sandstone already described. It appears again in Oswego, on Little river, near Panther lake, extending about one-fourth of a mile. It occurs again near Amboy centre, and also in Colosse at Petrick's mill: this locality furnishes a hard variety, and free from argillaceous matter. Then again it forms the lower fall at Mexicoville: this is the lowest part of the rock. The best and largest exposure of the rock in Oswego, is at Fulton, where it appears on both sides of the Oswego river. The upper layers at this locality are light colored, somewhat variegated as usual, and covered with the peculiar fossil of this rock, the *Fucoides harlani*. Some layers of slate appear a few feet below, which are succeeded by red and gray sandstone, suitable for building materials, hearth-stones, etc.

Again, in Cayuga county, the Medina sandstone appears in the north part. At Stirling centre, the exposed rock is about twenty-five feet thick. It appears at Martville, where it is of two kinds: a hard and variegated mass, with diagonal cleavage planes; and a coarse friable rock, of a color darker than the preceding.

In Wayne county, at Wolcott furnace, and on Salmon creek about two miles northeast of the furnace, this rock appears in a ravine. It is also quarried on Beard's and Little Red creeks, for building and for hearth-stones. Still farther west, in Monroe county, it appears on the lake shore in the town of Penfield. At the lower falls of the Genesee river, it is exposed for more than one hundred feet. At Medina, on Oakorchard creek, the rock is still better exposed and characterized than at any of the places which I have named. It is better, not because it is thicker, but because there is a better exposure of its fossils than elsewhere.

From Medina to Lockport, the harder part of this rock crops out near the line of the canal, or in a terrace which is formed by its protrusion. At the latter place, about one mile below the village, on Eighteen-mile creek, it exhibits the same characters as at the former place. Proceeding from Lockport to Lewiston, it is found forming a part of the slope of the terrace, and contributes principally to its height by the resistance which the hard middle portion has offered to the weather; while the lower portion, by its rapid change when exposed to the weather, and consequently by its destructibility, gives a more depressed surface to the country under which it lies. At Lewiston, it forms the banks of Niagara river, where it is exposed for two hundred feet. It extends towards the lake, but gradually slopes to its level, and disappears beneath the superincumbent clay.

Thickness. This rock is thin in Oswego and Lewis counties, but thicker as it extends westward, as we have already observed. It swells to the thickness of two hundred feet upon the banks of the Niagara river. On this river, too, it is more expanded than to the eastward. The entire thickness of the rock, as determined by the survey of Mr. Hall, upon this river, is not less than three hundred and fifty feet. The increase in thickness at Lockport and Niagara, over that of Oswego, is due to additions which were made to the inferior and softer portion of the rock. At Oswego and vicinity the rock is generally hard, and destitute of those softer and argillaceous parts which are so important in the western districts just referred to.

Agricultural characters of the Medina sandstone. The softer parts of this rock decompose, and form an excellent wheat soil; but its peculiar properties will be given in another part of this treatise. It is only west of Oswego county, where the rock is adapted by its nature to form a soil suitable to the growth of this grain.

Surface of the country over which this rock prevails. Two causes conspire to create a level country, through which this rock passes: 1, a freedom from igneous action; and, 2, evenness of composition in the rock itself, which secures a uniformity of action so far as atmospheric agents are concerned. The hard belt of reddish gray sandstone between Medina and Niagara forms an elevated platform, but the country is by no means broken into ridges: hence it is, so far as evenness is concerned, a good agricultural district. Streams which cross it, cut through the softer portions, and form impassable ravines or gorges; but these are not so frequent as to interfere with farming operations.

Reason why this rock should be studied. This rock forms an interesting chapter in the history of the progress of geology in this State. It was considered by the early cultivators of this science as identical with the New Red Sandstone of Europe, which overlies the Coal measures, that embrace the rock salt of the district of Cheshire in England. Hence these opinions led to speculations and explorations both for salt and coal, underlaid by this rock. This erroneous view arose from placing too much reliance upon lithological characters; for, in this particular, it closely resembles some portions of the New Red sandstone. Mr. Conrad and Mr. Vanuxem, however, were able, by the character of the fossils, to set this matter right in the first year of the survey.

Springs originating in the Medina sandstone. Brine springs issue from the lower part of this sandstone, but the water is too impure for the manufacture of salt. The fact is important in a geological point of view, as furnishing a high probability that it is from the chemical changes which the materials undergo, that salt is formed, the elements of which exist in the body of the rock. As in most instances of mineral springs in Western New-York, the chloride of sodium is adulterated with the chlorides of calcium and magnesium.

Geological relations of the Medina sandstone. This rock is succeeded in the ascending order by the green shales of the Clinton group. Below, it reposes upon the gray sandstone of Oswego county, which is equivalent to, and identical with, the gray thick-bedded sandstone of the Hudson-river series. It is wanting in the southeastern part of the State. In the vallies of the Hudson and Rondout, the Hudson-river series supports the shales of the Waterlime series (See Pl. XXI. Sec. 1; and Pl. XX. Sec. 3).

§ 2. Clinton group.

The most interesting feature in this group, consists in the rapid changes in the strata which enter into its formation, and which, taken together, constitute a most heterogeneous assemblage of materials: for this reason, the group was called, in an early stage of the survey, the *Protean group.* The formation consists of layers and beds, composed of green, blue, and brown sandy and argillaceous shales, alternating with greenish brown sandstones and conglomerates, or pebbly beds, and oolitic iron ore. These different kinds of materials rapidly succeed each other. The late Mr. Eaton called this formation *ferriferous slate*, and *ferriferous sandrock.*

The parts of this formation which are the most persistent, are the green shales; whose color, however, inclines more to blue than green, where they have not been exposed to weathering. The sandstone, which is rather harsh, in consequence of the predominance of sharp angular grains, is also greenish, or greenish gray. The layers of this part of the rock are never thick-bedded, or massive; and their lower surfaces are often covered with cylindrical bodies, varying in size from a barleycorn to that of the finger. These bodies have usually been considered as of vegetable origin, some of which have been figured and described as marine plants, under the generic name of *fucoids*. One fact, however, which is of some consequence as bearing upon the question of their origin, is that no two are precisely alike; and, taken as a whole, there is quite a diversity in the characters of an assemblage of those upon the same surface, though there is a general resemblance among them.

In Warren, Herkimer county, near Cruger's mill, the following strata appear in the ravine:

1. Bluish gritty shale, 1 foot.
2. Gray sandstone... 2 ..
3. Blue gritty shale.. 1 ..
4. Gray sandstone... 4 ..
5 – 6. Gray pebbly beds, 2 ..
7. Blue shale....... 6 inches.
8 – 9. Gray, and, by weathering, brown and fine-grained sandstone, 6 inches.
10. Iron gray sandstone disposed to weather, 6 inches.
11. Thin-bedded sandstone ... 1 foot.
12. Fine pebbly conglomerate, 6 ..
13 – 14. Layers similar to 12 .. 2 ..
15. Brown soft sandstone .... 2 ..
16. Dark colored shale and bluish black sandstone, 2 – 3 feet.
Associated with the above is a layer or bed of red argillaceous iron ore, concealed in the debris.

This heterogeneous series rests upon the Oneida conglomerate, of which it seems at the east to form a continuation.

The most easterly point where this group can be examined to advantage, is near Vanhornsville, on Otsquack creek, where an extensive exposure exists, and the rocks present the same characters as at Cruger's mill.

The following are some of the most important localities where the Clinton group may be examined:

In the town of Stark, the group is exposed on a small stream near Mr. Wicks. At this place, the strata consist of, 1, a conglomerate; 2, a green shale, which is succeeded by a white laminated sandstone with a few pebbles. The rocks which succeed the latter are green and grayish sandstones, and a shale. About one mile east, the shale is associated with gypsum, in a small portion of which sulphate of strontian has been found.

On Steel's creek, south of the village of Mohawk, is a cliff where the group attains its maximum thickness, which is not far from seventy feet. The beds of iron ore may be examined first between the east branch of Steel's creek, and the road leading to the Mohawk river: this is the lower bed of ore. On another branch of the same creek, to the west, the upper bed may be examined in place: it is an accretionary mass, made up of oolitic ore, and rounded fragments of organic bodies, which are coated with the peroxide.

Blackstone's, and Gaylord's and Norton's quarries are still more favorable points, where these rocks may be examined. The former is in the lower part of the group; the latter in the upper, and between them the ore beds of Mr. Wadsworth are situated. The beds are about twenty feet apart, and, upon an average, are not over a foot in thickness. Some portions are highly fossiliferous, consisting of separated stems of encrinites, and a few bivalved shells.

Again, the Clinton group is well exposed on Swift's creek, near its junction with Sauquoit creek. It consists here of a series of green shales, alternating with thin-bedded sandstone. The shale which succeeds the sandstone, is forty feet thick. It is succeeded by a thin bed of hard grayish sandstone fourteen inches thick, upon which reposes the lowest bed of ore. The ore is succeeded by twenty feet of green shale; and, as usual, it alternates with the thin-bedded sandstones, whose surfaces are covered with fucoids. Ascending still higher in the series, the succession of layers bear very much the same character as those below.

The parts of the group which contain the ore beds are exposed on the road leading to New-Hartford, and also upon the road from New-Hartford to Clinton, at Dr. Ruddeck's, southeast of Clinton; at Griffin's quarry, north of Hamilton College hill; and on the turnpike near the line of Kirkland, leading from Utica to Vernon.

The surface beds of the Clinton group spread over most of the areas of the towns of Westmoreland, Kirkland and Verona. At the latter place, one of the ore beds is immediately beneath the soil; and not far from the village, it is quarried for the Taberg Company; and a little distance to the south, it is quarried for the Lenox and Constantia furnaces. Its greatest thickness here is fourteen inches.

Leaving Oneida county, and proceeding to Madison, the first locality worthy of notice is at Donnelly, on the road from Canastota to the head of Oneida lake. The surface layer is still an ore bed, which stains the soil of a deep red. The series appears on Little Sodus creek, near Martville: it alternates with shale, some of whose beds are calcareous.

Pursuing the route of this group westward, we find it, as at the east, developed in ravines where the streams have cut into the strata, and have exposed their edges upon the banks. One of the most extensive localities is upon the Genesee river, below Rochester. It is necessary to observe, that at this distant point, the lithological characters of the rocks are altered, and from being sandy deposites, they are more shaly; and that calcareous matter also exists in greater abundance, and forms an important rock in the series.

The series at the lower falls of the Genesee consists of the following masses, reckoning from the superior layer of Medina sandstone, the gray band:

1. A tender fissile green shale, about 15 to 20 feet thick.
2. The lower bed of oolitic iron ore, associated with an impure shaly limestone, 14 inches.
3. A limestone, which, from the great abundance of the *Pentamerus oblongus*, is called Pentamerus limestone, 14 feet.
4. The latter is succeeded by a shale, whose characters do not differ much from the mass below, and at the base of the series, 24 feet. This, however, embraces two or more unimportant masses of limestone, which will arrest the attention of the observer by the great abundance of the *Atrypa*

hemispherica. It is in this second mass of green shale, that the superior bed of iron ore occurs in Oneida and Madison counties.

5. Impure thin-bedded limestone, with thin seams of green shale, 18 feet.

At the steamboat landing, the following series exist upon the east side of the Genesee :

1. One hundred feet of Medina sandstone.
2. From fifteen to twenty feet of green fragile slate.
3. From four to six feet of sandstone.
4. Six inches of the oolitic iron ore.
5. Ten feet of sandstone alternating with shale.
6. Eight inches of limestone containing the ***Pentamerus oblongus.***

Near the locks of the canal at Lockport, there is from thirty to thirty-six feet of shale, and from ten to fifteen feet of limestone, containing many encrinal stems. The shale, at its junction with the limestone, is a disintegrating mass.

The thickness of the rocks at Lockport is as follows :

1. Medina sandstone exposed ..... 60 feet.
2. Limestone shale and green shale, 70 ..
3. Niagara limestone............ 20 ..

The shale below the Niagara limestone, predominates greatly over the limestone or hard layers, or the impure siliceous limestones.

At this place, then, the change in the lithological characters of this series is still better marked and more decided. Here the limestone and shale only remain : the coarse rough sandstone and conglomerates, and the iron ore beds, are entirely absent. These, it will be seen, constituted at the east the most important parts of the series. The same observation applies to the series as it exists in Orleans and Niagara counties. On the Niagara river, the limestone is about twenty feet thick, and the shale has diminished to four or five feet. This change in the mineral constitution of the group is both interesting and important. It is important, inasmuch as the change is one which is peculiarly favorable to agriculture : the hard and scarcely decomposable sandstones and conglomerates of Oneida become soft decomposable slates and shales, before they reach the Genesee valley.

General distribution of the Clinton group. I have stated somewhat in detail the peculiarities of this group, as it appears at many places on and near the route of the Erie canal. A general statement, however, of the distribution of the series is still required. The first well characterized beds appear in the southeast part of Herkimer county, near Vanhorn's in the town of Warren. The series forms a narrow belt, and, extending westward, are exposed to view at the quarries of Blackstone and Davis, two and a half or three miles south of Utica. The north border runs about northwest, and intersects the Erie canal about half way between Rome and Oneida lake. From this region, the series extends westward to Niagara, as has been intimated. The greatest width of the belt is between the Oswego river and Sodus bay, or rather in the town of Wolcott, where it approaches within two miles of the lake shore, and where it can not be less than fifteen or twenty miles wide. This, too, is the most important part of the series, as the iron ore beds are better developed than either east or west. At Rochester, the series is about eight miles wide, which width it retains to the Niagara river. It crosses the Genesee below Rochester, and forms the little ridge on the north side of the canal, or a low terrace which runs nearly parallel with it. The canal soon intersects this ridge, whence it then extends on its south side to within eight or nine miles east of Lockport. From Lockport it forms a sort of slope or terrace, which extends to Niagara river.

Oneida lake, and the low marshy grounds in Cicero, are excavated in this group. Its distribution, and the width of the formation, together with the course of the southern boundary, may be seen by an examination of the map: the belt is colored green.

Relations of the Clinton group. To the eastward this group is superimposed upon the Oneida conglomerate. The disappearance of this mass, as the series extends westward, seems to alter or change its relations; for instead of passing beneath the Medina sandstone, which it meets in the northern part of Oneida county, it takes a position superior to it, and hence the Medina sandstone becomes the supporting mass or base throughout its whole distance to the Niagara river. Superiorly the group is merged in a shaly sandstone, which, if it does not coalesce with the more perfect limestone called the Niagara, still does not disappear abruptly and form a strong and well marked line of demarkation with it.

The relations of this group, then, are by no means obscure on the route I have described. We should expect, however, from so perfect a development of a series within this section of the State, that it would also appear within its bounds wherever the inferior and superior rocks are found; but this is not the case. Thus in the valley of the Rondout, the Oneida conglomerate forms an important rock, and ought to be succeeded by the Clinton group; but instead of this being the case, it is wanting. The relations of the rocks of this part of the State are represented on Pl. XX. Section 3: see also the same plate, section 2, which extends across the valley of the Schoharie creek. The same absence of this group will be noticed in the section at Cherryvalley, still farther west, on the main sectional route from Albany to Auburn. It is only, therefore, in the direction and vicinity of the Erie canal, that we are to look for this series; parallel with which, it extends across the State, from near the eastern bounds of Springfield or Warren in Herkimer county, to the Niagara river.

Contour of the country over which the Clinton group extends. The most level and uninteresting part of the State, is that which is underlaid by the Clinton group. To be satisfied of the truth of this statement, it is only necessary to pass over the level and swampy lands about Oneida lake, and the Cicero swamps. The long levels of the canals, too, extend over this series. There is, however, some interest in the scenery of the deep gorges: thus, at Cruger's in Herkimer county, but especially in the deeper and wider gorges of the Genesee and Niagara rivers, the scenery is imposing; but in consequence of the absence of disturbances in this rock, the surface above it is invariably dull and monotonous. If, however, this section of the State rises at all into ridges, they are not all connected with this formation, but have resulted from the operation of far more modern causes than any which have acted upon it. It is true that these rocks form a part of the mountain ridge in Niagara county, extending from Lockport to Lewiston ; still they appear only in an inferior slope, which gradually dies away, and is lost in the lower grounds which succeed it towards the lake. It is in fact an inconsiderable elevation, rising only three hundred and fifty feet above Lake Ontario and the surrounding country. The tortuous course of this ridge, however, adds something to the variety of surface. In general the country descends towards Lake Ontario, from near Rome to Niagara, in a very gradual manner. At the termination of this group, there is a single steep offset ; but at Lockport, and most of the intervening country, there are two terraces, which are formed by the presence of the sandstone below, and the soft shales which succeed, together with the hard limestone that forms the surface rock of this part of the district. The uneven surfaces, then, which are due to the rocks of this group, exist mostly in Niagara county ; and the hilly surface elsewhere corresponding to this group, is formed by the action of diluvial currents, which have brought together sand, gravel and boulders, and arranged these materials in the form of ridges and rounded hillocks.

Waterfalls in the Ontario division. I have just referred to the influence of running waters upon the soft rocks which compose in the west a large proportion of the Ontario division, and by which deep channels are cut. These, if interrupted by hard layers, form cascades or falls in the stream, as the waters are longer resisted by these harder deposits. Most of the high falls in the State are thus produced, and two remarkable instances have just been spoken of. The Niagara fall, the most commanding of all the phenomena of this kind, is formed in this division of the New-York rocks ; a part of which, called the American Fall, is represented in Pl. X. It is inferior in grandeur to the Great Horseshoe Fall. It was drawn from the Canada side.

Agricultural capacity of the soil of the Clinton group. The nature of this formation, at its eastern termination, favors the production of a siliceous soil ; while at the west, owing to the predominance of argillaceous and calcareous matter in combination, the soil partakes of the composition of the parent rocks. It is difficult, however, to estimate the influence which this formation exercises on the soil, as it is underlaid at the west by a rock also allied to a marl, or which at least decomposes like one. I allude to the parts already described of the Medina sandstone, which constantly crumbles by the action of atmospheric agents, and passes into soil. So in the superior masses, it is soon succeeded by a marly deposit, the only rock which intervenes being the Niagara limestone. It is therefore unnecessary to dwell upon the influence this mass exerts, as it is merged in the rocks above and below, all of which are particularly and nearly equally concerned in the production of the peculiar soils of the western counties. Much of the country, however, which is underlaid by the Clinton group, is low and swampy, and hence unfavorably situated for exhibiting the true value to be placed upon the soil which it has formed.

The sandstones and conglomerates of Herkimer decompose slowly ; but the process is aided by the interlamination of the green shales, which, however, do not crumble so rapidly as those of Wayne, Orleans, Monroe and Niagara counties. The shales of the latter counties undergo the process sometimes called *slaking*, which consists in falling to a powdery state even when they are dry. The change, however, is far more rapid where they are exposed to an alternate action of atmospheric agency. It is almost impossible to prevent the decomposition of a piece of shale when it is wetted after having been thoroughly dried. This fact teaches us the mode by which they may be converted into renovators of the soil; for it is found that they contain several valuable salts, which are important in promoting the growth of vegetables. We shall recur again to this subject in another place.

Minerals usually associated with the rocks composing this group. The most important mineral is the oolitic iron ore, which forms distinct strata by itself: it is a calcareo-argillaceous ore, and is used for castings, but not for bar iron. Masses of chert, in which are cavities lined with quartz crystals, are not uncommon in the layers of limestone. Sulphate of barytes, of a red color, occurs in the oolitic iron at Wolcott furnace. Crystals of carbonate of lime, sulphate of lime, pyritous copper and iron, and green carbonate, are sometimes found in several of the masses belonging to this group.

Miscellaneous remarks. The most remarkable feature, as already observed, is the sudden and repeated changes in the mineral type of the layers and rocks which enter into this formation; and perhaps the presence of those singular beds of iron ore, is not the least interesting of the facts connected with it. That a mass whose average thickness does not exceed one foot, should be spread out so extensively and by itself, unmixed with other matter, is a circumstance of great interest, and worthy of special investigation. The source of the iron is not well determined. In Jefferson and St. Lawrence counties, the red specular oxide of iron is abundant; and the beds which are now open, exhibit the fact that they have at some former period suffered from denudation and transportation in a southerly direction, but this occurrence belongs without doubt to a period long posterior to the formation of the oolitic iron. Still it is rational to believe that these northern beds may have furnished the materials for the iron of the Clinton group; and it is evident that these masses were brought to the surface at a period subsequent to the deposition of the Potsdam sandstone, and the event may have happened in the era of the Clinton group. There is yet nothing discovered that militates against this view of the origin of the iron in question.

The Clinton group is not confined to the State of New-York: it is found in Ohio, Pennsylvania and Canada. Its thickness in New-York, according to Mr. Hall, does not exceed eighty feet. It is between fifty and sixty feet in Warren in Herkimer county.

§ 2. Niagara group.

Geodiferous limerock, and Calciferous slate, of Eaton; Lockport limestone and Rochester slate, Upper part of the Protean group, of the Annual Reports.

This name, as proposed, is selected from the place where the group is best developed, and where it not only is well situated to arrest the attention of the curious, but also occupies a point more generally visited than any other within the bounds of New-York. It consists of only two distinct members, and hence is comparatively a small group, or one which is composed of a small number of members.

1. In the ascending order, thin laminated bluish green shales, tender, and subject to disintegration.
2. Dark blue limestone, the lower beds or beds of passage argillaceous: the beds of passage into the limestone are silico-argillaceous; when recently exposed, they are of bluish green; on exposure, they become gray.

The limestone is often distinguished by cavities lined with crystals of pearl and dog-tooth spar, and hence received the name of *geodiferous limestone* by the earlier writers on geology.

1. Niagara shale.

The color of this shale is dark bluish, which invariably whitens on exposure to the weather, passing into laminated fragments, and finally into a stiff clay: alternations of a dry and wet surface favor this change. The whole mass is slightly calcareous, but the lower parts do not furnish calcareous bands; the middle and upper, however, exhibit interlaminations of impure limestone.

2. Niagara limestone.

This rock is dark colored and bituminous; often strongly so. It admits of the following subdivisions:

1. From the shale upwards, beds of gray siliceous limestone, often quarried for cement, or for hydraulic mortars.
2. Thin-bedded shaly limestone, alternating with seams of dark colored shale.
3. Thick-bedded limestone above; below, the beds are thinner, and often bent or contorted, or even concretionary.
4. Bituminous limestone, cherty, thin-bedded and gray or brown: geodes abound.

At Rochester, the limestone is crystalline, sparkling upon a dark ground, and brittle, breaking with an uneven fracture: it is quite harsh, and apparently siliceous.

At Lockport, the Niagara limestone appears with some additions to its strata:

1. Reddish gray crystalline limestone, susceptible of a fine polish: the color is due to the numerous broken stems of encrinites.
2. Concretionary and irregular-bedded limestone, with cavities containing spar in various forms.
3. Bituminous limestone with cavities, generally dark colored.
4. Gray limestone, with thin bituminous shale between its layers.

In Oneida and Herkimer counties, this rock first appears as one of the members of the New-York system; and so different are its features where it first appears at its eastern position, that it would not be recognized as the western geodiferous limestone, if it could not be traced almost uninterruptedly in its western route. It takes its origin only a few miles west of the Clinton group, which it accompanies all the way to Niagara falls.

On Swift creek in Oneida county, it is a dark concretionary mass, about four or five feet thick, accompanied with a dark colored slate. The concretions form segments of large curves or semicircles, and may be split or separated from each other in tables a yard square or more. The mass possesses the same characters at Hart's mill, Steel's creek, near Hamilton College, at Vernon, and near Skanandoa. As the rock proceeds west, it becomes a purer lime, and loses in part its concretionary character.

Range and extent. Commencing a little farther west than the Clinton group, and in a slender band only, the Niagara group traverses the middle and western counties of New-York in a closely parallel band with the inferior mass just described. It becomes an important rock in Monroe county. Its northern outcropping edge passes through Penfield, Brighton, Ogden and Sweden. In Orleans and Niagara counties, the northern edge forms an outcrop in Clarendon, Albion, Medina, Royalton, Lockport, Cambria and Lewiston. Throughout this distance, the rock is not sufficiently altered in its lithological characters to require comment.

Minerals usually associated with this group. The most noted and most sought for species are those which occur in the geodes at Lockport. They consist of pearl spar in crystals with curved faces, the dog-tooth spar in dodecahedral prisms, and a variety of sulphuret of iron in long slender prisms. Galena is rarely found in this rock in New-York. Gypsum or selenite, and sulphate of strontian, are common minerals in the geodes of spar, and occasionally cubic crystals of fluor spar. Anthracite coal is also rare, but is sometimes found.

§ 3. Thickness of the Ontario Division in New-York.

The combined results of the observations and measurements of the strata composing this division of the New-York system, are as follow :

Medina sandstone, which constitutes the base of the division,	350 feet.
Clinton group	80
Niagara shale	100
Niagara limestone	164
Maximum thickness	694 feet.

§ 4. Summary of the principal facts relating to the Ontario Division.

1. This division in the State of New-York, is the least extensive, and of the least importance of the four or five divisions under which the strata are described.
2. The Medina sandstone and Niagara limestone are the best entitled to the appellation of general strata.
3. The latter marks the termination, it would seem, of a distinct era in geological history, whose importance, however, can not be well estimated in New-York.
4. The only mineral deposit of importance consists of a calcareous oolitic iron ore.
5. Agriculturally, some of the members of this division are not only interesting, but important, in the middle and western part of the State.
6. The country over which this division extends, is level, but is liable, from the soft nature of the materials of which the rocks are composed, to be cut and traversed by gorges and ravines, that give origin to falls and cascades, of which those formed by the Genesee and Niagara rivers are the most important (See Plates 9 and 10).

PLATE IX

III. HELDERBERG DIVISION.

Remarks descriptive of the appearance of the Helderberg range from the hills east of Greenbush, and explanatory of Plate I.—This range is remarkable for the succession of terraces as it rises from its eastern slope, and for the offsets after it has attained its height towards the north or valley of the Mohawk. Each terrace marks the position of the several limestones, which, being harder than the shales, form permanent tables extending beyond the limits of the shales, that are confined to an outcropping and nearly horizontal edge. The slope or dip is southwest, and the range rises from beneath the Catskill mountains, which rise up in dome-shaped segments upon the left. We see, in this view, merely the eastern slope: to the west there is a succession of minor ranges, separated from each other by north and south valleys. The Hudson-river series appears in the foreground, and are colored purple; the limestones are colored blue, the shales a light drab, and the Catskill sandstones (which are the superior rocks, and beneath which all disappear) a light brown.

§ 1. Onondaga-salt group.

If we estimate the importance of a group or series of rocks by the amount of useful materials it furnishes, then this group is certainly one of considerable consequence. This will be admitted, probably, when it is stated that it furnishes most, if not all the plaster used in Western New-York, and much that is used in the New-England States. It undoubtedly gives origin to the brine springs from which a large proportion of our salt is made, and from which an immense revenue is derived by the State. Besides these important considerations, the rocks themselves form by decomposition an excellent soil, and the belt over which the group prevails is one of the best agricultural districts in the State of New-York. Without doubt, then, if this view is the true one, this group becomes both geologically and economically important. Its relations and associations are inquiries of considerable moment; for it is essential that its position in the series should be well understood, and the nature of the deposits forming it well determined. Such being our opinion in regard to it, we proceed to describe the series in the same order which has been observed in the preceding groups.

The specific characters which distinguish this group from the preceding, and the different members which form it. Leaving out of view those characters which are derived from its organic remains, we find that it is composed in the ascending order, of,

1. A red shaly fissile mass with green spots and a few bands, constantly breaking down under the action of atmospheric agents.
2. Green shale, rather massive, in which plaster beds are embraced, and which also contain casts of crystals of hopper-shaped cavities in which common salt once existed.

3. A gray impure limestone, in which there are numerous small irregular-shaped cavities or cells, resembling those of lava or amygdaloid. These beds are associated with the above.

4. Thin-bedded shaly limestone, passing upwards into a fine-grained one whose thickness has increased: this limestone emits a ringing sound when struck. These beds constitute the Manlius waterlime series of the Reports.

It is proper to observe here in regard to this last division, which is a deviation from the reports, that there seems to be a gradual passage upwards, from the thin-bedded fragile shales and shaly limestones, to the thicker and firmer beds of the last division. There is no well marked line of divison between the lower and upper masses of the group, as defined above. The Pentamerus limestone, which succeeds the waterlimes, is clearly a different rock. Below, the Niagara limestone is a very distinct deposit in all respects ; but when we once pass into the Onondaga-salt group, no characteristic lines can be discovered, which seem to be suitable to the purpose of serving as lines of demarkation. Then again it is our wish to diminish the number of groups, as far as possible, without doing violence to arrangements founded in nature.

I shall now proceed to speak in detail of the division which I have just proposed.

1. Red shale.

The ground color of this mass is a blood-red, upon which patches of green are common ; and sometimes or in some parts of it there are strata which are entirely green, a red shale alternating to a limited extent with green. The true character of these beds is so much concealed by their own debris, that it is often unnoticed. The rock is extremely fragile, and is constantly breaking down by the action of the weather : hence the surfaces exposed look more like a marl bed than a solid rock. The fracture is earthy, and the divisions which usually mark the strata are obscure, if not entirely absent.

Localities where this rock is exposed. As has been stated in regard to the commencement of the Clinton group, this rock too does not appear east of Herkimer county. At Steel's creek, at Cruger's mill, and between Mohawk village and Dennison's on the Sauquoit creek, on the north and west side of Paris hill, the red shale crops out, and appears under the characters which have been given above. Farther west, but still in Oneida county, the rock appears near Hamilton College ; from which place, it spreads out and extends into Madison county, in the eastern part of which it is cut through by the Erie canal. In its western prolongation into Onondaga and Cayuga counties, it forms a band to the north, but it runs nearly parallel with the Canal. Still farther west and in the vicinity of Genesee river at Rochester, the rock exists but obscurely. It was excavated in a well in Brighton, four miles south of Rochester. Mr. Hall expresses some doubts of its continuance farther west than this river, unless indeed the character of the rock is changed.

Thickness of the red shale. Mr. Vanuxem estimates its thickness in some places at five hundred feet, or as varying from one to five hundred feet. On the West branch of Steel's creek, it forms a mass, in a precipice or perpendicular cliff, eighty feet thick.

Extent of the red shale in New-York. It is highly probable that it is limited to the district which is indicated by the localities already cited, by which it appears to form a narrow belt running parallel with, but a little south of, the Clinton group, commencing in Herkimer county, and terminating in Monroe in the vicinity of Rochester. A red shale, spotted with green, rests upon the Oneida conglomerate at the High falls of the Rondout; but this seems to belong to a higher part of the group. The same red shale underlies Becraft's mountain near Hudson. It only shows itself upon the east or northeast side, and then but obscurely. These localities are cited, in order that observers may not be deceived by the strata which so much resemble those of Onondaga county, and which form the base of the plaster and salt deposits. These red beds are probably above both the plaster formation, and that part of the shale which gives origin to the brine springs.

2. Green shale, with the plaster beds.

This portion of the group begins with red, green, drab, and yellow-colored shales alternating several times; the green and drab colors, however, predominate, and it is probable the red may be wanting in some places. Like the lowest portion just described, it has the same disposition to decompose after disintegration has taken place. In some limited places, the debris of the rock is lodged upon the shelving and projecting undecomposed parts of the same, like ashes, or in a light powdery condition, and having a strong bitter taste of epsom or glauber salts. This portion, too, when exposed in cliffs, or when penetrated by wells, shows the strata traversed by thin columnar gypsum, either white and translucent, or reddish and opake in the mass. Besides the fibrous gypsum in thin seams, selenite is not uncommon, but usually in small laminated transparent masses diffused through the crumbling rock. Opake gypsum too is abundant in it, but not in beds sufficiently large for quarrying; and it may be, that in some localities, one quarter of this portion of the group is a sulphate of lime. Such then are the characters of this first mass above the red shale, which, however, it is proper to say, is firmer at its superior part, becoming gradually a shaly limestone with thick and oval beds of plaster, and finally so sound and compact that it emits a ringing sound when struck with a hard body.

Fig. 24.

Section of the lower green shales embracing the lower plaster beds, which appear generally as irregular seams, some composed of fibrous gypsum.

a. Gypsum beds enclosed in green shales both above and below, all of which disintegrate, and then undergo a real decomposition: the process may be seen in the harder shelving parts of the rock, or beneath, where the debris is partially sheltered, and where there is often half a bushel of fine gray ash-like substance of a bitter taste.

Localities where it may be observed. Though this rock may exist in Oneida county, yet it is too obscure, or too much concealed in its own, or in the debris of other rocks, to attract much attention.

In Camillus, at the railroad cut, is one of the best localities for studying this division of the group. The place is west of Camillus village, and can not fail to attract the attention of travellers over this line of conveyance. More than one hundred feet of it is exposed, and in all the conditions and with all the products of which I have spoken, except that the red rock is not exposed or does not exist at this place.

Another locality of interest, is about three miles east of Manlius centre, at the Green lakes, where the superior part of this division exists with massive beds of plaster. This is superior to the rock at the deep railroad cut in Camillus. The limestone shale at the lakes is thin-bedded and fragile, but not so much so as the mass below.

At Cayuga bridge, the same series is exposed in the banks, where many oven-shaped cavities exist, from which plaster has been extracted, or from which it has been dissolved by water percolating through the strata.

The lower mass exists still farther west, in the vicinity of Lyons, Newark and Lockville: at the latter place, the locks for the enlarged canal are excavated in it. Westward beyond the Genesee river, it is exposed in Byron and Alabama; and at Bergen centre, the railroad runs near the excavation for plaster. At Palmyra, it is upon the banks of the canal. In Erie county, the beds are concealed by thick beds of drift. Some few excavations expose it sufficiently to prove its continuation.

Fig. 25.

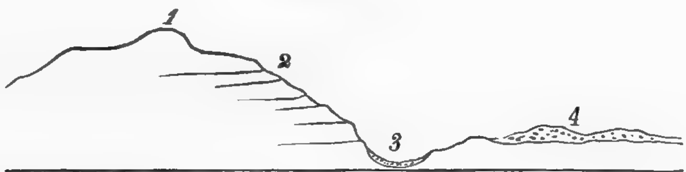
Section illustrating the position of the lakes, with the vermicular limerock of Eaton, *or porous limestone.*

a. Canal. *b.* Green lakes, sometimes called Lake Sodom. *c.* Porous limestone: plaster beds above. T. Manlius village. The section extends south three miles, passing over the formation embracing the plaster beds; the highest strata are the waterlime layers on the slope of the hill. The hill intervening between the Green lakes is traversed by fissures, through which most of the water percolates until it reaches the more impervious strata, the green shales. The water of the Green lakes (of which there are two) is unpleasant, or rather bitter; contains a great amount of lime: every twig or stick which happens to fall into it becomes incrusted with carbonate of lime. They are situated on small but deep depressions or basins, which, unlike many others in the surrounding country, are not formed by drift currents, or by streams that have mechanically worn them out; neither are they produced by fractures or uplifts, as the strata are undisturbed. To what cause is to be attributed the basin-shaped depressions in which these lakes are contained, is a matter of speculation, that has not as yet been satisfactorily determined.

A general statement of the extent of this division of the Onondaga-salt group. Beginning as heretofore, at the east, we find the green shales and gypseous rock first appearing in Oneida county, near Vernon village, where, as is stated by Mr. Vanuxem, the constituents of the lower part of this mass were thrown out from a well, such as fibrous gypsum and selenite embraced in fragments of green shale. From this extreme eastern point of the rock, it widens and deepens westward, but probably attains its fullest development in Onondaga county, in the vicinity of the principal salt wells and springs. But few of the characteristic marks of this rock appear in Monroe and Erie counties; and probably it thins out to such an extent, that it is but feebly represented in the extreme western counties. The belt which it forms, then, though not confined to the central part of the State, is still wider and deeper there than elsewhere, especially the lower part so well known by the hopper-form cavities. At a low stage of the Niagara river, it appears in the banks at Grand island. Mr. Hall speaks of this mass as not uncommon in Monroe and Wayne counties, but as hardly known in Genesee or Erie.

Interesting feature in the region of the plaster beds and green shales. That these rocks are easily worn down, and are liable to be cut deeply by running water, has been stated already; but the combined action of running water and of atmospheric agencies generally, has not been sufficiently explained. Perhaps I ought also to include diluvial agency, as particularly active in giving shape or contour to this part of Onondaga county. The feature which I propose to speak of, is exhibited in the numerous high and round eminences that occur upon the plains, like immense mounds. They are quite round, sloping steeply and equally in all directions, with summits almost perfectly oval or round: they are sixty or seventy feet high, and from their summits many others are seen; indeed they command fine views of the surrounding country. The rock sometimes crops out from a point, showing by this that they are not entirely drift hills. Section 26, though not designed to illustrate the form of the hills, will give an idea of some of the facts which stand connected with them.

Fig. 26.

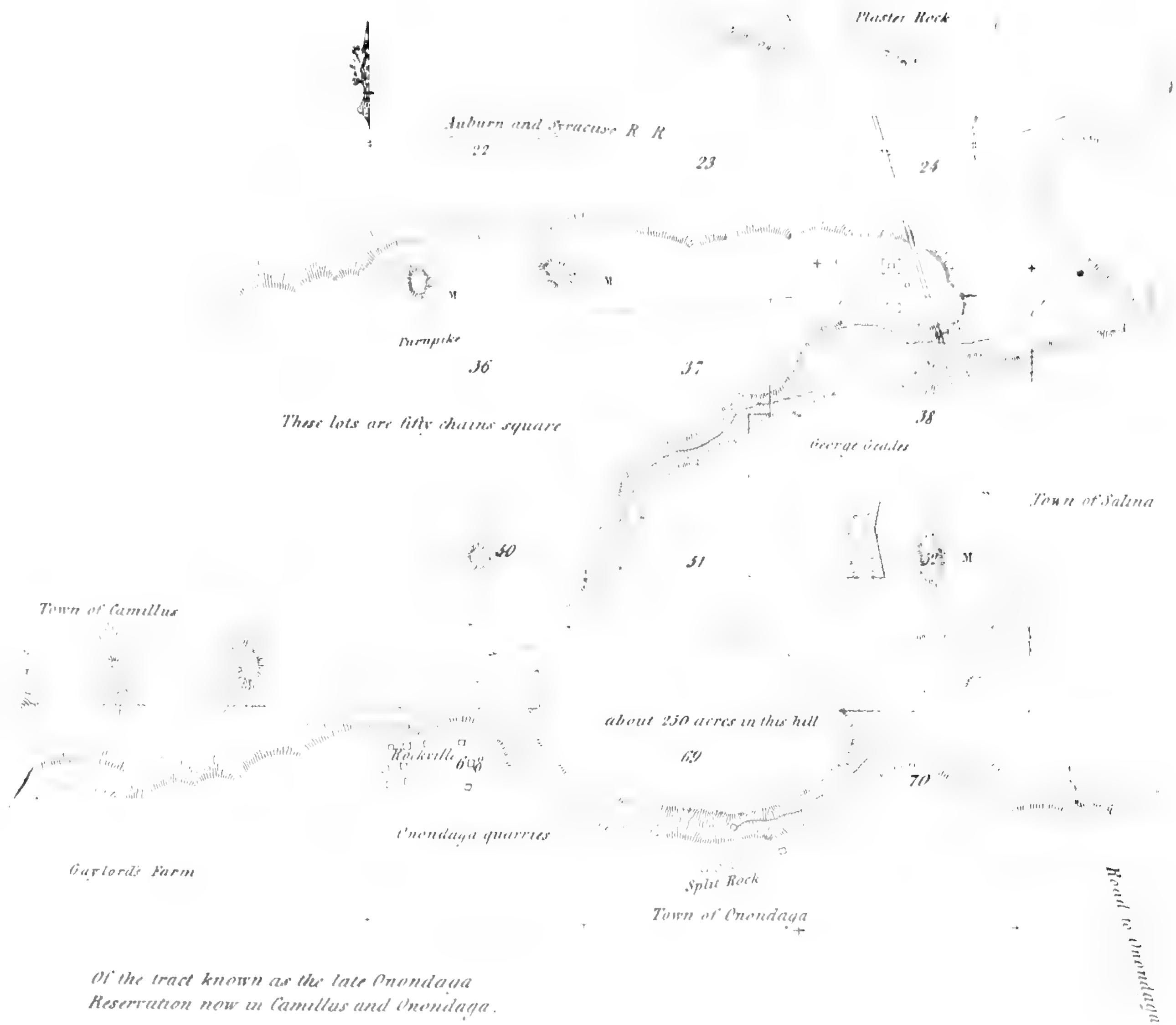


1. Round hill, the highest points of the immediate region. 2. Gypseous rock. 3. Tufa deposits. 4. Drift, made up of fine and coarse cobblestones.

As I have intimated that these hills, and the peculiar shape of the country, are not entirely due to diluvial action, nor to present atmospheric agency, it may be expected that some other cause shall be assigned for the phenomena under consideration. In searching for something explanatory of these changes, I found that near the outcrop of the Onondaga limestone, circular gorges, or what might be called very appropriately roadways, occur, which encompass, in the instance before us, an area of two hundred and fifty acres. This area presents nearly a semicircle of perpendicular ledges on both sides, whose height is not far from one hundred feet. By some means a cleft of a circular form has been made in the mass: in the instance exhibited in the annexed map, it is thirty rods wide, and the cliffs, though circular, run parallel with each other; and the road space is as free of rocks, boulders, and fragments of cliffs, as any part of the adjacent country. In fact a clear sweep has been made directly into the rock to the depth of one hundred feet, and in width twenty-five or thirty rods, giving all this space for a forest, or, if necessary, for a meadow. Now it is imagined that these breaks or fractures in the rocks have laid the foundation for the numerous hillocks of the surrounding country, they being in a more advanced stage. They are composed beneath of insulated outliers of the same rocks; but by the action of a variety of causes, the space between them and the main range of the same rocks is greatly enlarged. The accompanying map, which has been drawn by my friend George Geddes, of Tyler Post-office, will explain more than I am able by words, or by an elaborate description. M, M. Mounds; L, L. Roadway, or, as it is called in the neighborhood by the significant name *Splitrock*. The map, for other details, explains itself. The roadway slopes east and west: the west part is perfectly dry; on the south part, a small sulphur spring rises, which runs into a small pond *b*. The surface rock of the two hundred and fifty acres is the Onondaga limestone, and so it is on both sides of the roadway. It is difficult to account for such a separation, unless by subsidence of one side; but as the rocks of the same kind correspond very nearly in height, an objection is thus interposed to this view; though it must be admitted that this, after all, is the most plausible view, when taken in consideration with the nature of the rocks beneath, namely, the plaster beds and green shales, etc., which may in many ways be removed, and thus undermine the hard superior rocks. Whatever cause may have been instrumental in the production of this natural dry roadway, we certainly consider it as among the most interesting geological features in Onondaga county. They differ materially from the deep ravines and gorges which constitute water courses (those, for instance, of the Genesee and Niagara rivers), in which, wherever they occur, if hard rocks form a part of the series, cascades or waterfalls are produced. On a magnificent scale we see this remark exemplified in the Niagara river, where the hard Niagara limestone forms a barrier in the form of a table, over which the waters pour, and send forth their everlasting thunders in their fall (See Pl. X.).

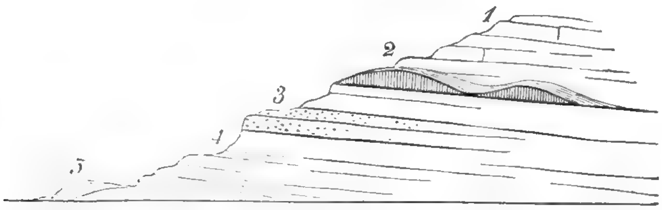
3. Impure gray porous limestone.

I place this rock by itself under a distinct head, because it is an anomalous rock. It belongs geologically to the preceding or second division of this series, the Onondaga-salt group. In position, it lies between the two plaster beds. The rock is extremely fine-grained, even, and compact between the irregular-shaped cavities. It is even-bedded, however, dividing distinctly into layers or strata, like other sedimentary rocks. The cavities, or pores, as they exist in some places, are empty, certainly in all that part of the rock which is at or near the surface. It is sufficiently described, when it is said that it resembles very closely a lava.


Plaster Rock
Auburn and Syracuse R R
22
23
24
Turnpike
36
37
38
These lots are fifty chains square
George Geddes
Town of Salina
40
51
Town of Camillus
about 250 acres in this hill
69
Rockville
70
Onondaga quarries
Gaylord's Farm
Split Rock
Town of Onondaga
Road to Onondaga
Of the tract known as the late Onondaga
Reservation now in Camillus and Onondaga.

The relations of the masses now under consideration, are well developed on Nine-mile creek, where the following section was obtained :

Fig. 27.



1. Green shales. 2. Plaster beds, whose forms are usually oval, and appear like unconformable masses in the shale. 3. Porous limestone. 4. Green shales, with their seams of columnar gypsum. 5. Tufa beds, which are continually forming on the brows and at the base of almost every slope where the green shales make the underlying rock of the region.

Opinions of its origin. From its lava-like structure, some geologists regard this rock as the product of a mud volcano. Perhaps there are no facts which very strongly support this view, or militate against it. The pores, however, are not so much like those of lava, when closely inspected, as they seem to be when viewed only cursorily. They are not such as are usually produced when pent air is expanded in a semi-liquid rock, and forms thereby a small cavity. In these cases there is a smoothness upon the inner surface, which is due to the pressure of the air upon a soft yielding body. The pores of the limestone are excessively angular or jagged, as if some substance had crystallized in them, and was subsequently dissolved, leaving the open space unoccupied. We may suppose that these porous layers were sediments like the rest of the formation, but contained much crystalline matter, which has disappeared by solution. Still it is true that mud is ejected from volcanoes, and is spread over wide areas, which, from the laws of soft movable matter, will become, on solidifying, a stratified rock, provided the mass is not fused or excessively heated, in which case it would rather become a crystalline unstratified rock similar to granite.

4. Thin-bedded shaly limestone; the superior part constituting the Manlius waterlime group.

This part of the salt group may be described as consisting of thin-bedded calcareous shales, near the plaster beds, whose colors are usually bluish gray, excepting a few beds which are red or red mottled with green in a manner similar to the red shale at the base of the group. The beds are all thicker above, or superiorly ; but they are always fine-grained deposits, and supposed to be impure carbonates of lime, containing magnesia, iron and alumina.

This part of the group has been usually described by itself, under the name of Manlius waterlime. As the purposes for which a notice of the New-York rocks is introduced are better answered by considering the whole mass above the plaster beds, up to the Pentamerus limestone, as one division, we have disregarded the former grouping in this respect.

I propose describing the superior division, as it exists in different parts of the State; as this, like several other groups or sub-groups, exhibits many important variations in the composition of the individual strata.

Valley of the Rondout in Ulster county. The best, or perhaps the most interesting exposure, is at the High falls. The series at this place stands thus in the ascending order:

1. Oneida conglomerate; or, as it would be called here, the Shawangunk grit of Mr. MATHER.
2. Thin-bedded red and green shales below impure thin-bedded limestones; above, similar in form and structure to the Manlius waterlimes. The inferior part contains many irregular-shaped geodes lined with crystals of lime, and the brown and red masses contain many implanted crystals of sulphuret of iron: some of these crystals are liable to decompose.
3. A grayish white grit, ten feet thick. It resembles the grits of the Clinton group in Herkimer county; but it will be understood that this remarkable mass, in this position, is above this group, and hence is not an equivalent of it at this place, but is an intercalated portion.
4. Thick irregular-bedded cherty limestone, geodiferous in some parts: it is dark-colored. It is probably the pentamerus in part blended with the delthyris shaly limestone, as some portions are drab-colored and shaly. The thick dark-colored layers are quarried for cement.

The falls of the Rondout are produced by an uplift, in which the entire series enumerated above are broken three times (See Plate XX. Section 3).

One remarkable fact is worthy of notice in the valley of the Rondout. Near Rosendale, the Hudson-river series supports and is in connection with the shaly limestones I have just noticed; so also the same relations prevail near Catskill, and at Becraft's mountain. At the falls of the Rondout, however, the Oneida conglomerate is in connection with the Waterlime series. It is possible that the series described as the waterlimes may be a disguised form of the Clinton group, and the limestones referred to the pentamerus and delthyris would then become equivalents with the Niagara group. A fact which supports this view, is the existence of the *Catenipora escaroides.* Sufficient time could not be taken to settle the question in regard to the true character of these rocks. At the time they were examined, they were considered as the waterlimes, and equivalent to those of Onondaga county; and it is in this light that they have been regarded thus far in this report.

If the red mottled shale is equivalent in part to the Clinton group, it is wanting in the characters by which this series is known in Oneida and Herkimer counties. The fucoids are absent, and the limestone beds replace the grits which abound in the counties just cited. The decomposing green shales, with cavities lined with crystals of calc spar, resemble very closely a mass which lies just above the village of Manlius, and which is there soon succeeded by a thin band of the Pentamerus limestone. These remarks will prevent in a great measure the inculcation of error, as they will serve to put the student in the track of inquiry when visiting the valley of the Rondout. Mr. MATHER regards a part of the series here as belonging to the Clinton group. In whatever light, however, we may regard this series, the thin shaly beds, which in Onondaga county contain gypsum and the hopper-form cavities, are certainly wanting, and they have not been recognized in this part of the State. They ought not, it is true, to be found at the falls of the Rondout, if the series consists only of the Clinton and Niagara groups ; the former comprising the shales, green, red and mottled, and the ten feet of sandstone ; and the latter, the limestone at the head of the falls, which is quarried for cement. The plaster beds in this case ought to be found above the falls, resting upon the cement rock or the Niagara limestone.

The waterlimes are also exposed on the eastern outcrop of the Helderberg, on a range not far west of the Hudson river, near the villages of Kingston, Saugerties, Catskill, Leeds, Coxsackie, Coeymans, New-Baltimore, and also on the east side of Hudson river at Becraft's mountain. At all these localities, the upper beds are the ones which are exposed, and which are ranked rather as thin-bedded limestones than as shales, the latter being always disposed to disintegrate rapidly, and pass into the condition of soil.

Other parts of the Helderberg range also furnish important points of exposure : thus, about one and a half or two miles east of New-Scotland in Albany county, the same series of beds appear ; and these may be traced around on the northern outcrop, or rather terminus of the Helderberg range, as far as Schoharie. Still onwards through Carlisle, Cherry-valley, Springfield, Warren, and through Oneida and Herkimer counties, they maintain much the same character. In Onondaga county, the lower part, and that which crops out in the village of Manlius, is shaly, and green or drab-colored, with cavities lined with crystals of lime. This part can not be distinguished from that at the falls of the Rondout, of which I have expressed some doubts whether it is to be regarded as belonging to the Waterlime series or the Clinton group.

In Onondaga county, the series terminates abruptly above ; a fact of considerable importance in fixing the limits of the series, as the circumstances show that an important change took place in the condition of the seas in which these rocks were in the progress of formation.

At Manlius, the exposed rocks are as follow :

1. Greenish shales with imperfect geodes, fragile, and rapidly decomposing: exposed in the road above the village.
2. Thin-bedded limestone, which becomes of a drab color on exposure to the weather.
3. Compact black thick-bedded limestone, much broken, in thin beds, from eight to ten feet thick.
4. This is succeeded by a lighter colored limestone, eight feet: this last supports a few feet of the Pentamerus limestone, which is quite concretionary.

The mass which is burnt and used for hydraulic cement, is the upper four feet of the drab-colored No. 2, and just beneath the black compact limestone. It is a mass thicker bedded than the lower part of the same tier, from which it is not very easy to distinguish it.

At Auburn, the quarries north from the town give nearly the same series. The black rock, with a small univalve, occurs in great abundance at both places.

In Monroe county, Mr. Hall gives a section at West-Mendon, consisting of the Onondaga salt group, twenty-five feet, in thin courses of light drab or ashen hue, succeeded by a thin band of Oriskany sandstone. The bed usually quarried for cement, is not noticed; though at Vienna in Ontario county, it is two feet thick; and in Genesee county, at Morganville, the waterlime is thirty-eight feet thick, consisting of four feet in thin courses, twenty-two feet in thick courses (in combination with silex), and twelve feet in gray layers with seams of blue marl. The series terminates below in the green and grayish fragile shales or marls.

The development of the upper part of the series I have been describing, is best in Schoharie county, while the lower part is best exposed in Onondaga county. At Schoharie village, the following series occurs at the strontian locality, on the slope west of the creek: 1, Hudson-river series, three hundred feet exposed; 2, Waterlime series of the Onondaga-salt group, consisting of blue thick-bedded limestone, and greenish or drab-colored shaly limestone, one hundred feet, and pentamerus, twenty feet. Between the Hudson-river series and the waterlimes, the red shales are feebly developed, and contain, as at the Rondout falls, numerous crystals of sulphuret of iron. Developed also in and beneath the mass of thin-bedded limestone containing strontian and barytes, is a mass of compact blue limestone about eight feet thick, in which favosites abound, and which is scarcely known out of Schoharie county.

Soils of the Onondaga-salt group. The debris of the rocks of this group is almost uniformly of a drab color, and it may be usually traced to the source from which it is derived. It becomes fine by the slow process of disintegration; constantly furnishing, in the changes it undergoes, suitable materials for vegetable food. The soil, as might be expected from the character of the rock, is excellent: it possesses a sufficient tenacity for the growth of wheat; but sometimes, especially where the clay predominates, it acquires too much tenacity for indian corn. The clay beds possess the same colors as the soil, only they are of deeper tint.

It will be noticed, from the preceding description of the localities where these rocks are developed, that the lower parts of the group furnish the best soil, as they undergo more rapid decomposition. The process is slow in the superior portion of the waterlimes, still the soil furnished in each case has the same general character; but in consequence of the great development of the lower portion in the central part of the State, the soils are much more widely spread and extended than to the eastward: it is, moreover, derived from the rocks themselves, and without intermixture to any considerable amount of the northern drift.

The soil and clay of this series may generally be distinguished from that of the slates of the Hudson-river series: the latter is bluish, and rarely of that distinct drab-color possessed by those derived from the waterlimes, although it is true that the upper clay of the Hudson river series is of a drab or yellowish brown color. As I propose to treat of the soils of the different rocks under a separate head, I leave this subject at present.

Springs and wells whose origin can be traced to the Onondaga-salt group. Probably no series of rocks furnish such a variety of soluble products as the Onondaga-salt group; and for this reason, the name is quite appropriate. The quality of the water which has percolated through these strata differs according to the depth it has penetrated, and the place from which it has its exit. Those springs which issue just beneath the Waterlime series, and above the green shaly mass, furnish very good water to drink. So the wells that receive the water which has only percolated through the same strata, furnish very good drinkable water, though it is never soft, or free from the sulphate and chloride of lime. Again, those springs which issue from the green shales, and whose waters have not penetrated through the plaster beds and the masses in which the hopper-form cavities occur, are medicinal waters, or springs similar in composition to the Sharon springs. Of these springs, a great many are found issuing from the northern outcrop of these rocks, and they extend from the Helderberg to Buffalo nearly in a line. But the most important are the brine and acid springs, and the salt wells: these issue, and derive their waters, from the inferior mass. The saline as well as the acid matters are derived from the rock, or the rock furnishes all the elements from which they are spontaneously formed by active chemical changes, or decomposition and recomposition. Wherever the sulphurets of iron abound, they give origin to the acid astringent salts. The vegetable matter about these springs is charred, and intermixed largely with the soil and with oxide of iron, so as to forms mounds four or five feet high around them. The hepatic or sulphur springs derive their properties, also, from the decomposing sulphurets. The sulphur is often deposited upon leaves, sticks and stones, over which the water flows, and which is sometimes white and sometimes bluish black.

Another class of waters, differing from the preceding, may be termed, from their composition, *lime waters*. They are perfectly transparent, and flow usually in the greatest amount from the inferior or middle strata. They have given origin to the numberless beds of tufa which occur on a level, or else below the terrace that skirts the south side of the Erie canal. These waters, though cool, are unfit for use.

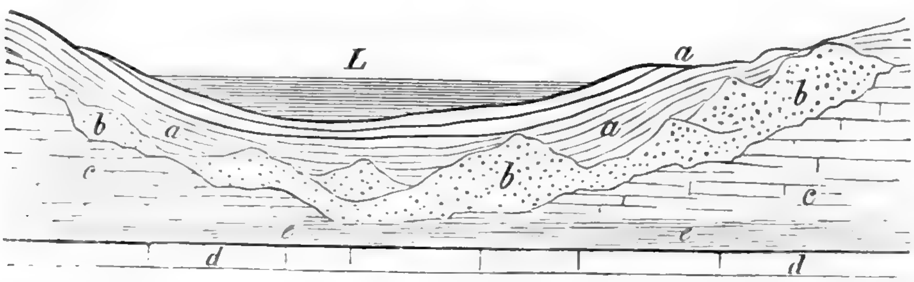
Wherever the Manlius waterlimes form the surface rocks, however great the area, no springs or wells can be obtained in them, except at their base, or at the beginning of the green shales, which, being comparatively impervious, throw out the surface water when it reaches them. Thus at Manlius centre, there is a hill near the village, and directly north, which has probably four square miles of surface, in which no water can be obtained by digging, until the base is reached. From this base, many active and living springs issue, which in the aggregate furnish sufficient water for several streams each large enough to turn a mill, and indeed several mills are moved by the water direct from these springs.

The brine springs and salt wells, without doubt, come from the deepest part of this formation. They may be obtained at almost any point, by sinking a deep well, upon the Onondaga reservation. A singular fact, and which at first view seems to militate against the opinion that the saline waters are derived from this rock, is that the best wells are sunk entirely in the drift, some of which penetrate three hundred and fifty feet. In those instances where the rock is not penetrated at all, it appears that the salt water was originally absorbed by the gravel, sand, clays, etc. which constitute the drift beds. However this may be, it seems more rational to suppose that deep excavations, forming basins, have been hollowed out of these rocks, into which the drift has been precipitated. These drift beds are quite pervious, but they rest on an impervious foundation; and the saline waters, which are supposed to be formed in the rock, flow out and accumulate in the beds of drift, which, when penetrated, give exit to them. This appears from the fact that when, on boring, the instruments soon penetrate into the drift, the workmen are encouraged to proceed, because experience has proved that in such a case a great flow of water is sure to be obtained.

There is another fact worthy of notice, and which is important to the valley of Onondaga lake: it is this, that an impervious stratum of marl overlies nearly the whole region. This serves to keep the surface waters from intermingling directly with the waters below, or, in other words, requires the water to penetrate from the distant slopes, and to traverse a large space in order to reach the basin of the lake, and thus to become highly charged with saline matter. This impervious stratum of marl overlies all the beds, inasmuch as it is the most recent. Whether it is now increasing in thickness, is not determined. Tufa is continually forming; and all the waters of this region, being charged with calcareous matter, must part with it whenever their flow is interrupted, and hence we see it gathering upon stones, sticks and leaves, and even in many cases petrifying them.

The annexed diagram (fig. 28) is an imaginary section of the basin of Onondaga lake, and represents our view of the relations of the masses concerned in the origin of the Onondaga salt springs.

Fig. 28.



L. Onondaga lake. *a, a, a.* Impervious marl. *b, b, b.* Drift nearly filling the valley. *c, c.* Gypseous shales with hopper-form cavities. *e, e.* Red shale. *d, d.* Niagara limestone.

The salt wells penetrate the drift to the depth of 340 – 350 feet, and quite large cobblestones have been brought up from that depth. The strength of the water increases with the depth. The stones brought up, are derived from the harder parts of the Medina sandstone.

It is proper to remark, before closing, that it is not well settled whether the salt, the chloride of sodium, is merely a dissolved salt already formed and enclosed in the interstices of the rock, or is actually formed daily from elements contained in the rock, and which require to be brought together before the chloride of sodium can be obtained. We are obliged to remain in darkness on this subject; while upon the origin of the other saline and acid springs, there is no doubt but that they are formed from the decomposition of the materials in or of the rock itself.*

General remarks on the middle and upper members of the Helderberg division. It has been useful, up to this point of my description of the New-York system, to throw many of its series into groups, which, mineralogically considered, have some striking characters in common. Thus the last series described consists of four, and perhaps more members, which graduate into each other: they may be quite different apparently at their extremes, still we are unable to discover where it would be necessary to consider them as distinct rocks. When, however, we reach the rocks which form the Helderberg and Schoharie ranges, beginning with the Pentamerus limestone, we find it necessary to abandon the plan of throwing the series into groups, and to adopt that of describing the succeeding rocks as distinct individual masses. Limestones, it is true, predominate, and we might describe them under some such appellation as this, namely, the *Schoharie limestone group*, were it not that the limestones resemble each other so faintly, that the combination of this common name would form an assemblage as heterogeneous as possible. If, for example, we compare the Delthyris shaly limestone with the Onondaga limestone, we may see at once that they are incongruous rocks. So the same may be said of the Pentamerus and Onondaga limestones; and finally, no two of the rocks can be grouped together without violating some principle of classification. But what still makes the difficulty greater, is the presence of three beds of anomalous sandstones, which, neither lithologically, nor by their fossils, can be associated together, or with the limestones which are adjacent to them. For these reasons, then, the succeeding rocks of this division are described individually as independent rocks. It is not intended, however, by these remarks, to convey the idea that there is nothing in common among them; for some fossils pass upwards through two or more rocks, and thus link them together by conditions which must have been somewhat similar at the period they were deposited.

Metamorphic rock. At Syracuse, a mass resembling serpentine appears in the gypseous rocks: it is yellowish green, passing into deep green with a tinge of blue. It softens and whitens on exposure to the weather. It effervesces briskly with acids, and hence contains considerable carbonate of lime. The interior is hard, and sometimes siliceous and extremely tough. Mica, hornblende, and indeed very well characterized granite, have been observed in a portion of this rock.† It takes a fine polish, and would form a beautiful serpentine marble if it was of a uniform texture and hardness. The origin of this rock is not well determined. Mr. Vanuxem regards it as having been formed by a chemical union of its elements in solution in water. This view is adopted in preference to that of an

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* The green shales, and a part of the Onondaga-salt group, were inadvertently placed in the list of rocks which compose the Ontario division, p. 141.

† Vanuxem's Report, p. 109.

igneous injected mass, similar in its formation to a trap dyke, inasmuch as there are no appearances of ignition upon the adjacent rock.

§ 2. Pentamerus limestone (Plates xx. and viii.).

This is a gray crystalline limestone, with thick beds from its beginning. Its beds, however, are uneven, and some are concretionary and extremely rough; in fact, as will be seen, this concretionary mass is the most persistent and extensive. Its name is derived from the great abundance of a fossil called the *Pentamerus galeatus* (See Vanuxem's Report, p. 117, fig. 1). It is constant in the rock as far west as Herkimer county; but at its extreme western limit, it is rare, if it exist at all.

Points where this rock may be examined. The most eastern limit of the rock is Becraft's mountain, about three miles southeast of Hudson, on the road to Catskill: it forms two or more high bluffs on the east side of the road. Again, west of Catskill, or on the railroad between Catskill and Leeds, or on the turnpike between the two places. So also it is an outcropping mass on the west side of the Hudson river, forming the first of a series of cliffs from Kingston point to Coeymans. At numerous places also nearer the main hills of the Helderberg ranges, this rock is constantly present in heavy beds, whose aggregate thickness is about thirty feet. Another extensive outcrop of this rock forms the northern brow of the Helderberg hills: it exists in cliffs, formed by its outcrop, from Knox to Herkimer county, where it begins to lose this character, and to become more depressed. At Cherryvalley, at the head of a ravine, it seems to have attained its maximum development: from this point westward, it begins to thin out; and when it has reached Manlius, Onondaga county, it is only a few feet thick, and destitute of its characteristic fossils or other marks except its peculiar concretionary structure. At Tyler Post-office, and at Geddes, five miles west of Syracuse, the Onondaga-salt group is in contact with the Onondaga limestone, this whole mass having thinned out entirely.

Uses. This rock is totally unfit for purposes of construction: it is rough, and makes an indifferent wall. A part of it forms the cement rock of Ulster county. As a limestone, for ordinary purposes, it is not esteemed; for agricultural purposes, it may be well adapted, but has not been tried.

Range and extent. It will not be difficult to trace this range of limestone, from what has been said already. It begins at Becraft's mountain, near Hudson; forms one of the highest outcropping rocks in the first tier of hills which bound the Hudson valley west, from Coeymans to Kingston, and thence from Kingston to the falls of the Rondout. The same may be traced from Coeymans west to Manlius, and disappears entirely a few miles west of Manlius. The belt it forms is every where inconsiderable, and would be more properly represented by an outcropping edge.

Relations and connection of the Pentamerus limestone. Below, every where in New-York, it is succeeded by that part of the Onondaga-salt group which is called the Manlius waterlimes. Above, and at the east, it is succeeded by the Catskill shaly limestone. Near its

PLATE VIII

western terminus at Manlius, it is succeeded by the Onondaga limestone, the rocks which interpose at the east between it and the onondaga in the valley of the Hudson being discontinued (See Pl. XX. Main section 1; also sections 2 and 5).

Disturbances which the Pentamerus limestone has suffered. It is principally in the valley of the Rondout that this rock has been disturbed to the greatest extent, in common with its associates. Upon Catskill creek, three miles west of the village of Catskill, near the railroad, the rock is not only elevated, but curved as represented in Pl. IV., forming an interesting and rather picturesque view. The effect is due to lateral pressure and the joint operation of an elevating force, which has fractured this thick rock, and separated it from its continuity. It appears in the face of a precipice 250 – 300 feet high. The exposed rock at the top of the eminence is the Pentamerus limestone.

Terrace and outcrop of the Water and Pentamerus limestones, as they appear in the Schoharie range (Pl. viii.). The semi-panoramic view in Plate 8 gives a better idea of the outcropping rocks of the Helderberg, than can be conveyed by description alone. The series of rocks in this plate are the same as those of Pl. I. of the Helderberg range, except that the Old Red sandstone does not occur within the field of view. The naked perpendicular cliffs are formed of the pentamerus, which is the superior and prominent rock, and the thin-bedded waterlimes which are directly beneath. The superior masses are the Onondaga limestone and Marcellus shales; the inferior, the thick-bedded Hudson-river series, which extends north to the valley of the Mohawk.

§ 3. Delthyris shaly limestone (Pl. xx. Sec. 1).

The passage of the Pentamerus limestone into the Delthyris shaly limestone is rather abrupt or indistinct. The entire mass of the shaly limestone is argillaceous; some layers consisting of slate, which disintegrate: others resist the action of the weather for a long time, and are extremely tough and difficult to break; they all, however, become drab-colored externally on exposure to the weather, while internally they retain a bluish color. The grain is fine, and unlike the pentamerus; in fact, the harder layers are nearly compact. The limestone throughout is impure, mixed with argillaceous matter and silex, and for this reason it is unfit for lime. It is useless too as a flagging stone, and is only good for stone fences.

Distinctive characters. It is not difficult to distinguish this rock from the preceding limestones, when once we have become familiar with its aspect; still, the best characters are derived from its fossils. Several species of *Delthyris* are confined to it (See Vanuxem's Report, p. 120, and p. 122 for figures of a few of its characteristic fossils).

Extent and limits of the Delthyris shaly limestone. It requires to be traced in a line, as, with the exception of one or two limited patches, it appears only in an outcropping edge. At Becraft's mountain it is one of the principal rocks: this is its eastern limit. It forms a north and south outcropping edge near the west side of the Hudson, from Kingston point to Coeymans; and from thence west, it accompanies the Pentamerus limestone as far as the eastern border of Madison county. It is twenty or twenty-five feet thick in Cherry-valley. Where the streams from the south in the Helderberg range open into the valley of the Mohawk, this rock is usually exposed on the east and west sides, as at Schoharie and Cobleskill creeks.

Soil derived from this limestone. So far as the disintegrating mass is concerned, the soil is of an excellent quality; but the rock is too limited to exert important effects by itself.

Thickness. Its maximum thickness is at the base of the Helderberg, where it is seventy or eighty feet thick: at Schoharie, it is sixty feet thick. It is sixty or seventy feet at Becraft's mountain; thence, from the Helderberg, or near New-Scotland, it continually diminishes in thickness to the west.

§ 4. Encrinal limestone (Pl. xx. Sec. 5, 6).

This rock may be considered by itself, or it may be regarded as the terminal portion of the preceding rock. It differs from the preceding very clearly in its high crystalline structure and light grey color; but a green matter, or a thin stratum of that peculiar shale derived from the same sources as that of the delthyris rock, appears between its layers, showing that both rocks were derived from one common origin. In composition, it is essentially a pure carbonate of lime crystallized throughout: it is remarkable for the stems of encrinites, which, from something peculiar to these organic bodies, give the rock frequently a reddish tint.

Value as a marble. It is proper to place this mass among the marbles, as it receives a good polish, and is used to some extent for mantle pieces and jambs. It is not, however, a profitable rock for this purpose. It is a strong durable stone, less subject to decomposition than the delthyris shale.

Thickness. Its maximum thickness is twenty-five feet. It is scarcely ten feet thick at New-Scotland.

Extent. It accompanies the Delthyris shale as far west as Sharon springs, where it disappears; at least the writer did not observe it at Cherryvalley, where the Delthyris shale is not less than twenty feet thick, and where it onght, if continued, to appear superimposed upon the shale. Its agricultural characters are unimportant. Its geological relations are also scarcely deserving of notice. Above it is the Oriskany sandstone, when that is present. The pelvis of a large encrinite, of a mammillary shape, or rather shield-form, and nearly two inches in diameter, is considered as its most characteristic fossil. For other relations, see Pl. XX. sections 1, 2 and 5.

§ 5. Oriskany sandstone (Pl. xx. Sec. 1).

Among the many interesting rocks of New-York, this, which is placed at the head of the section, is one that has always excited its full share of attention. It is not because it is economically important, or of great thickness, but rather on account of the number and the singular association of fossils which are found in it. Sometimes, though it is but a thin mass, not exceeding a foot in thickness, it is composed almost wholly of organic bodies, being so crowded together that they appear a mass of shells. In addition to the number of the fossils, it is highly interesting to observe the sudden transition of genera and species that occurs in passing from the Delthyris and Encrinal limestones to the Oriskany. Almost every species in the two former rocks seems to have perished about the time the latter was in the process of deposition. To learn at this late day the cause of this sudden extinction of life in so many animals, is certainly no easy matter.

The Oriskany sandstone, being a clean sandy deposit, does not seem a sufficient cause in itself for occasioning such a loss of life among the tenants of the deep; though there is no doubt of the position that the mollusca have their favorite habitations, a choice in the materials in which they bury themselves, and in which they may seek their food. Still one would hardly suppose that simple sand would prove so injurious to life, as to destroy entire races. Hence it is more natural to suppose that some change preceded the deposition of the rock, to which must be attributed the catastrophe under consideration. This change may have consisted simply in the elevation of the bottom of the sea, while the preceding deposits were accumulating. This seems to be a rational hypothesis, inasmuch as there is a change in the kind of materials which compose the sandstone. Previous to this rock, there were calcareous deposits, mixed with sandy argillaceous ones; afterwards there were siliceous deposits, which must have come from another direction. The reader of course will understand, that all the rocks which we have had under consideration in this chapter, are formed of sediments abraded from preëxisting rocks, brought from a distance by rivers, to the oceans or seas which existed at this era. Again, the beings belonging to the era of the sandstone were not only suddenly ushered into life, but they were as suddenly put out of life, or, in other words, were destroyed as suddenly and as unceremoniously as their predecessors, and after an extremely brief period of existence.

Characters of the Oriskany sandstone. It is composed in the main of coarsish angular sand: in this respect, it is unlike many of the sandstones in the New-York system. The sand is usually gray or yellowish, but sometimes white. Pebbles or rounded stones are not common, if they ever exist in it: it is, at any rate, far from being a conglomerate. Although the sand seems to be held together without cement, yet the presence of lime is indicated by effervescence in a very large proportion of the rock, even in that portion which to the eye appears altogether sandy.

Localities where this rock is developed. Near the village of Leeds in Greene county, this rock is crushed in, and concealed or greatly obscured by contortions which it has suffered along with its associates (See Pl. XX. sec. 5). But the Helderberg range is the region where this rock, for a thin one, is quite conspicuous, namely, on the road to New-Scotland, near Mr. Clark's; in Knox, on the road to Schoharie; at Schoharie, on both sides of the valley, but more particularly on the western terrace, and also at Cherryvalley; at Auburn, and four miles west of Auburn, on the road to Cayuga bridge. It forms an outcropping edge all the way from near Catskill to Cayuga bridge. It is eighteen inches thick at Auburn. It extends on this line no farther west than the last mentioned locality. It is proper to say, in this connection, that from its hardness, it frequently forms a narrow terrace, something more than merely an outcropping edge; but it never properly constitutes the surface rock of a continuous belt of country, as many of the New-York rocks do.

In giving the preceding localities, it is not designed to intimate that they are the only ones at which this rock may be examined with profit, but they are leading localities in the range in which it appears in its northern outcrop. Many others exist at intermediate places, and this is perhaps found with a greater certainty than any other in the New-York series, and hence becomes one of the important landmarks in studying the system.

Thickness of the Oriskany sandstone. At Leeds, compressed between its associates, it is only six inches thick; at the rise of the Helderberg mountain, east of Clark's, it is one foot; at Schoharie, two feet; at Cherryvalley, about eighteen inches; at Oriskany falls, twenty feet; at Perryville, and below Cazenovia, only a few inches; between Elbridge and Skaneateles, on the old Seneca road, thirty feet;* at Auburn, eighteen inches; a mile and a half south of Onondaga hollow, seven feet.* In places still farther west than any which have been named, a sprinkling of its peculiar angular sand is all which indicates its continuance; yet out of the State of New-York, and within the limits of Pennsylvania, this rock is said to be seven hundred feet thick.

Relations of this rock in the New-York series. In Hudson river district, its relations have been spoken of: it succeeds, in the ascending order, the Encrinal limestone; above, it is succeeded by the Cauda-galli grit. West of Cherryvalley, however, where some of the succeeding rocks disappear or thin out, it is immediately below the Onondaga limestone. These are the relations of the rock in Onondaga and Cayuga counties. The Hydraulic limestones are in contact with it below, and the Onondaga above. We have already stated that the Pentamerus, Delthyris and Encrinal limestones disappear in succession. The same fact exists in regard to the two rocks which intervene between the Oriskany sandstone and the Onondaga limestone. Near Mr. Geddes, at Tyler Post-office, the Oriskany is represented by a few boulders of the Niagara limestone. One was removed from beneath the Onondaga limestone, and found to be more than a foot in diameter: this mass belonged to the bituminous part of the Niagara limestone.

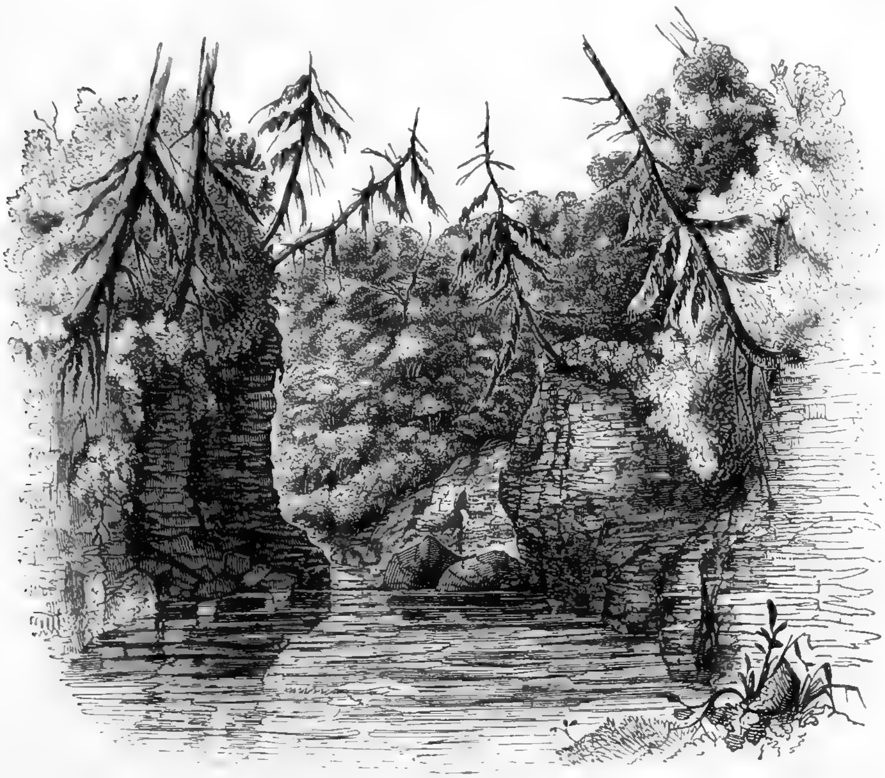
Some peculiarities worthy of notice which accompany this rock. At a few localities, the lower part of the rock is a dark-colored sandy limestone. Fossilized wood, in angular pieces, as if broken by violence, have been found in the rock at New-Scotland.

This rock is widely distributed in the drift south and southeast of the Helderberg. At the base of the Catskill mountains, in many of their gorges, and on the summits of the highest ridges in Greene and Albany counties, excepting those of the Catskill, boulders of the Oriskany sandstone are abundant. Many have found their way over the valley of the Hudson, and lie upon its eastern side, far beyond the limits of the rock.

* Vanuxem's Report, p. 126.

The agricultural characters of this rock are unimportant; and no mineral, excepting a jaspery iron ore, has been found in it (See VANUXEM's Report, pp. 125 – 6).

Fig. 29.



§ 6. CAUDA-GALLI GRIT (Pl. xx. Sec. 1, 5, 6).

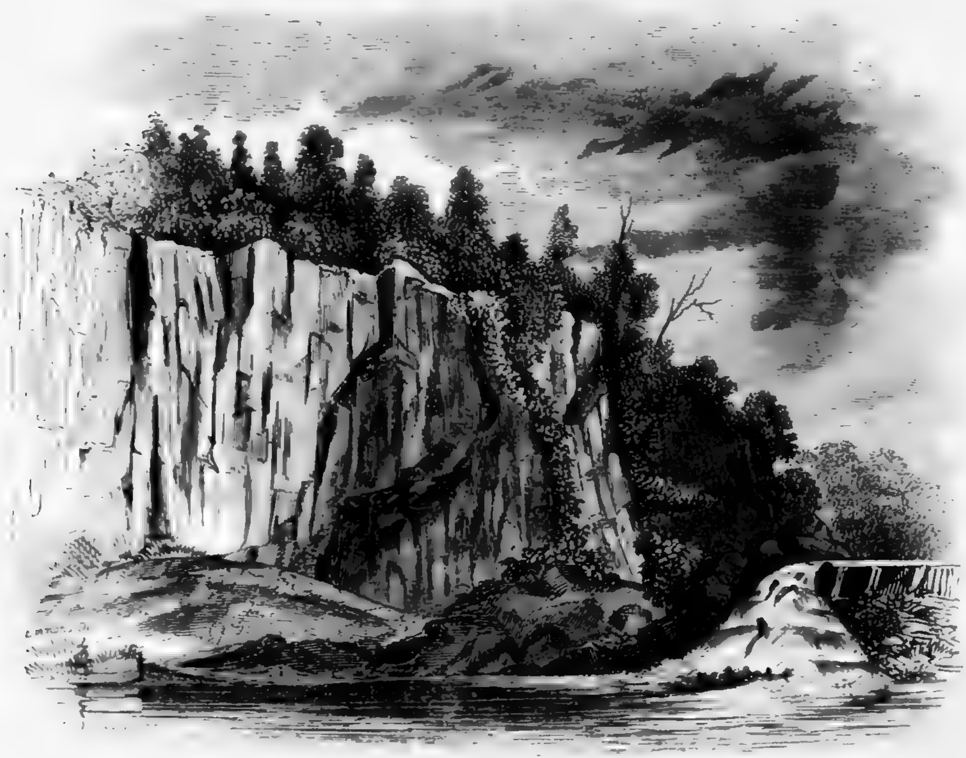
A spiral vegetable fossil, which, when flattened, appears like a cock's tail with its long flowing feathers, gave origin to the name of this rock.* It is a dark bluish sandstone beneath, with a quantity of argillaceous matter; and brown above, where this singular fossil abounds, though the lower part is not destitute of them, and they are even in some places impressed upon the upper surface of the Oriskany sandstone. The rock breaks down under the action of the weather: the first change in its integrity consists in the separation of the surface portion into short imperfect columns; and these continually diminish, until they pass into an imperfect gravel. It is thin-bedded throughout the whole rock:

* See Vanuxem's Report, p. 128.

the individual strata are indistinct, but the stratification is sufficiently manifest when viewed as a whole, and as it appears in a cliff. Fig. 29, at the head of this section, represents the usual appearances of the rock, where its horizontal strata are exposed. It is a view of the rock at New-Scotland, as it appears in the creek a few rods below the mill.

In some localities this rock is recognized with difficulty: thus, at Leeds in Greene county, in the disturbed belt, it is unlike the same mass at New-Scotland or at Cherry-valley. At the former place it puts on a columnar appearance, especially in the gorge below the village; and as the peculiar fossil is not readily distinguished, the geologist will inquire with some concern what the rock is, or what it is like? He will at first suspect that he has fallen upon a disturbed mass belonging to the Hudson-river series; and he will not be able to satisfy himself that it is really the Cauda-galli grit, until he finds it succeeded below by the Oriskany sandstone and Delthyris shaly limestone, and above by the Schoharie layers and a poor variety of the Onondaga limestone. The columnar structure is well represented in the mass by fig. 30, which represents the strata in the gorge at Leeds,

Fig. 30.



where the Catskill creek cuts through this rock, and exposes it upon its southwest side in a bold cliff fifty or sixty feet high. It is difficult to account for this singular instance of a columnar structure; for the strata are not vertically disposed, as we should infer from the exhibition of the cliff itself: this is proved by the fact that fossils are found between layers whose inclination departs only a few degrees from a horizontal position. The most rational conclusion which I have been able to form of this instance of disturbance, is that the strata have been simply crushed, so far at least as to obliterate the planes of deposition; afterwards, the weathering of the cliff completes the change, and imparts to it that peculiar columnar appearance which I have attempted to delineate in the cut.

This rock, though described under the name of grit, is quite an imperfect one: it is a harsh shale, though massive as a whole; and yet it is partially fissile, and splits into imperfect layers a quarter of an inch thick. No part of the rock is even-bedded, nor can be split into handsome plates or layers, but it is always more or less lumpy and uneven.

Thickness. This rock, in New-York, never exceeds sixty or seventy feet. It attains its maximum thickness at New-Scotland, where it is well known in the bed of the creek at Mr. Clark's, and where the layers for ten feet are impressed throughout with the flowing appearance of a cock's tail. Below, in the road and at the base, the rock is bluish black, and a few round or oval stems of vegetables often fall out of the mass, disconnected with the principal part of the vegetable to which they belong.

Extent or range of country over which the Cauda-galli grit prevails.

1. Near Coeymans, Coxsackie, Catskill or Leeds, this rock appears in a southeastern outcrop in which it is represented only by its edge: at each of these places, it is broken and disturbed.
2. The locality at New-Scotland has been referred to: it is the best place for an examination. At Schoharie, on both sides of Schoharie creek, it forms a terrace of a limited extent, with only a slight dip to the southwest.
3. At Cherryvalley, it is the surface rock near the great gorge one and a half miles northeast of the village: it is about fifteen feet thick, and crops out beneath the Onondaga limestone. It is also exposed between Cherryvalley and Springfield, and on the road between Fort-Plain and Richford springs, and in Warren and Herkimer counties. Farther west it is unknown, but the precise point where it entirely thins out is not determined.

For some general remarks on the fossil referred to, and for a more particular account of localities, see Vanuxem's Report, pp. 129 – 130.

Agricultural characters. It forms a miserable soil, which only gives support to stunted buckwheat: this at least is its character in Schoharie, where it forms a few limited terraces.

Relations. Its position in the Helderberg range, at Schoharie and New-Scotland, has been given. It stands in connection with the Oriskany sandstone below at Cherryvalley, and with the Onondaga limestone above, while the rock reposing upon it at New-Scotland is the Schoharie grit. For the disturbances which this rock has suffered, see Plate XX. sections 5 and 6; and for its general relations, see Pl. XX. section 1.

§ 7. SCHOHARIE GRIT (Pl. xx.).

This rock is a brown decomposing sandstone, in consequence of a mixture of lime, which dissolves, and leaves a granular tender mass that may be broken in the hands: hence it is always soft upon the outside, from disintegration by the action of the weather.

Thickness. In New-York, it attains a thickness of only four feet; and were it not that it is impossible to annex it to the inferior or next superior mass, it would be entitled only to the subordinate place of a layer.

Extent. It is confined to the Helderberg range; at least it does not reach Cherryvalley. It is about two feet thick at Leeds in Greene county, and appears on both sides of the church, resting on the Cauda-galli grit, which is elevated into a flat dome upon which the church stands (Pl. XX. Sec. 5, 6).

The general remarks upon the Oriskany sandstone, apply in part equally well to this rock. It succeeds a rock quite poor in fossils, a few mollusca only having been found in it as yet. Suddenly, however, a deposit is formed, which encloses a multitude of mollusca and a few crustacea. Some parts of the rock are formed of the remains of animals; and of these animals, it is quite doubtful whether any have been found in the inferior rocks. After four feet of rock had been deposited, not only the kind of material which for a short time had been in the process of accumulating, is changed, but the fauna is changed also; so that after a comparatively brief space of time, its numerous species of living beings became extinct, and gave place to others.

This rock, from its limited extent, is unimportant agriculturally; neither does it, or the next mass below, furnish mineral bodies of importance. Its interest is principally for the palæontologist.

§ 8. ONONDAGA LIMESTONE (Plates xx., xxi.).

It is designed to include under this designation a dark colored limestone, which has been described in the Annual Reports under the names of *Selenurus limerock*, *Seneca limestone*, and *Corniferous limestone*.

The Onondaga limestone is a gray and crystalline rock beneath, dark colored and somewhat shaly above, through all that portion which received the appellation of Selenurus limerock. Lithological characters are not competent to distinguish this from any other gray or dark colored limestone. Disregarding the fossils, we may look for its connections in order to be satisfied of its identity. Above, it is succeeded by a black shale; below, in the eastern part of the State, by the Schoharie grit and Cauda-galli sandstone; in the middle and western part of the State, by the Oriskany sandstone and Manlius waterlimes and shales. One feature which is interesting, though not distinctive, is that it contains chert or hornstone, or, as it is usually called, flint. It occurs in layers and irregular masses, which are the most abundant in the superior portion. In the Helderberg, it is not so distinctly in layers; but at Leeds in Greene county, it is made up of flinty layers in strata, or at least from eight to ten feet of the rock consist of two-thirds flint. At Cherry-valley, and farther west, the flint is in palmated and nodular masses, but arranged in strata: the interior of a flint nodule is often calcareous. It is the most cherty or flinty of any rock in the New-York series, and hence was named by the late Mr. Eaton, *Corniferous limerock*.

Extent or area over which the Onondaga limestone is the surface rock. It forms a narrow belt from the Hudson to Lake Erie. This belt is on the south side of the Erie canal. Its northern edge, beginning at Leeds, four miles west of Catskill, runs northeast to New-Scotland. It then sweeps round the northern terminus of the Helderberg range, but keeps south of the Cherryvalley turnpike. Its course is west from Schoharie to Blackrock, though it will be observed that the edge is rather convex to the north, in consequence of denudation which has taken place in the central part of the State, in the region of the smaller lakes, as Cayuga and Seneca. It passes through Onondaga, Cayuga, Genesee and Erie counties. The belt in some places is five or six miles wide, but considerably less in others (See the accompanying geological map, upon which its course may be traced, being the southernmost blue belt). In the Hudson valley, it appears in an outcropping edge, and also in a belt, sweeping round the base of the Catskill mountains, and passing a little west of the valley of the Rondout, or along the Warwarsing valley. It terminates, or passes out of the State of New-York, into New-Jersey, at the bend of the Delaware river.

Thickness. The whole thickness of the rock included under the name of the Onondaga limestone, is not less or more than sixty or seventy feet at Clark's in New-Scotland. It is not far from one hundred feet at Cherryvalley. At Leeds in Greene county, the whole mass does not appear to exceed twenty-five or thirty feet. At Leroy, the dark and compact part of the rock known as the Corniferous limestone, is seventy-one or -two feet, and is accompanied by thin masses of gray and dark colored limestone and hornstone, some of which is slaty. The amount of siliceous matter is large at Leroy. It then forms the limestone terrace, which continues onward to Blackrock. At the latter place, the calcareous and flinty portions are more or less blended, and the laminæ are separated by a dark colored shale.

If the rock is divided, and the lower mass treated as a distinct rock, it is found that it varies greatly in thickness on its westward route to Blackrock: in some places, as at the Helderberg and Cherry-valley, it is twenty-five or thirty feet thick; while at others, it is only three or four. Indeed the entire mass of the limestone is unstable as to thickness; and it may be said that, for a limestone, it is quite unsteady as to composition: in some places, the hornstone or chert predominates; in others, it is a pure limestone; and in others still it admits considerable shale into its composition, though it usually appears between the layers. The hornstone also differs somewhat in its characters: in one place, it is massive and in beds; in others, it is in nodules or palmated masses. As a whole, this hornstone belongs to the corniferous mass; in fact, it was owing to its great abundance that this name was given it. The impropriety of the name appears, however, when it is known that all the limestones in the New-York system contain it: even the Stockbridge limestone, in the Taconic system, contains occasionally a few layers of light colored hornstone.

Relations of the Onondaga limestone. At Leeds and New-Scotland, it reposes on the Schoharie grit; at Cherryvalley, upon the Oriskany sandstone; at Manlius, upon the concretionary part of the pentamerus; at Tyler Post-office, or rather a mile west, at Splitrock, upon the Manlius waterlimes, in which connection it continues to Blackrock. Above, from east to west, so far as New-York is concerned, it is every where succeeded by the Marcellus shales, a black shaly or rather slaty rock. At some other points farther west, however, there are vestiges of the Oriskany sandstone, and in a few places it has its usual thickness. For instance, five miles east of Cayuga bridge, as well as at Auburn, the latter rock is present: in a few localities, it is represented by a sprinkling of sand; at others, as at Splitrock, by a few boulders and cobblestones, which are mostly derived from the Niagara limestone, and some of which may possibly weigh fifty pounds. This may be regarded as an important fact. At the east, the Onondaga limestone is separated by several distinct and well characterized deposits from the Niagara limestone; but at the west, they are separated only by the red and green shales, and as these seem to be intercalated or rather local deposits, it is possible the two limestones may be actually in contact still farther west or southwest.

Natural joints and fissures. The Onondaga limestone is traversed with some show of regularity by joints, which, upon the surface, become wide fissures: these admit the passage of water; and, hence, wherever it is the surface rock, the rain subsides and passes through it, or to that stratum, whatever it may be, which is impervious, when it is thrown out. Owing to this stratum, no springs are found except at its base, and there frequently large ones issue at once of sufficient size to turn a mill-wheel. At Clark's in New-Scotland in Albany county, at Springport in Cayuga county, and at Clarence in Erie county, are springs of this description. In many instances, however, they are to be regarded only as subterranean streams, which have entered one fissure at a distance, and at last found their way out through another. The disappearance of Allen's creek at Leroy, which is noticed by Mr. Hall, is an example. This is not indeed an uncommon occurrence at the south and southwest, in the region of the Carboniferous limestone. The waters are cold, but are not sufficiently charged with inorganic matter to be entitled to the appellation of mineral waters: they are as pure as most springs in a limestone district, and they are quite unlike those waters which have percolated through the strata composing the Onondaga-salt group.

Agricultural characters. It has been generally supposed that this limestone exerted an important influence upon the agricultural productions of the central and western counties of New-York; indeed, that this rock furnishes one of the essential elements of a wheat soil, and was also principally instrumental in giving this character to quite a wide belt of country to the south, or beyond its visible limit. That it does exert an important influence is true, but not to the extent which has been supposed. From a careful collation of facts, I am rather disposed to attibute the high character which the western counties have enjoyed, and do now enjoy, as a wheat-growing district, to the lower part of the Helderberg division. It is here, as I have just pointed out, that the green and red shales, the plaster formation, etc., are situated, and to which, from their peculiar composition and their ready decomposition, we may with greater probability attribute this important feature in the agriculture of these counties. Upon this limestone, however, we invariably find an excellent and productive soil, and it is one which this rock has assisted in creating, but it is not, in the eastern or western part of the State, wholly derived from it; neither has the soil which reposes upon it a greater amount of calcareous matter, than has the soil of the next rock above or below it. It is a mixture composed of drift from a distance, and some derived from the green shales. It is not a rock which is very much subject to disintegration, and hence there is not an accumulation of calcareous matter, or an excess of it any where disseminated through the superimposed soil.

Mr. Hall, in speaking of this rock, remarks, that where it is thin, as in the eastern part of the district, it scarcely produces any effect upon the soil; but where it is thicker, it has essentially modified its character. Where hornstone prevails, and when the larger masses are removed, the soil, though quite siliceous or abounding in angular fragments of this mineral, is nevertheless always of the best quality. This is supposed to be owing to a constant supply of fresh calcareous matter derived from broken down fragments, which constantly acts as a fertilizer.* This subject will be brought before the reader again, when the peculiar composition of the soil upon this rock will be stated in detail.

Uses to which the Onondaga limestone is adapted. It is extensively employed for producing lime; and much that comes to the Albany market is from the Helderberg, and mostly from the inferior part of this rock, or the gray and white portions which are free from shale and hornstone. Where the rock is sound and free from flint or hornstone, it may be, and is to some extent, wrought as a marble: it is gray, and sometimes reddish, and then receives a tolerable polish, and besides it is durable and strong. It is well adapted to works in which a durable material is essential: it is not at all subject to disintegration where the surface is well wrought; neither is it traversed by fissures that open by frosts, in case the stone is well selected. It is, therefore, one of the most important and useful rocks in the New-York series.

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* Hall's Report, p. 170.

TABLE *exhibiting the thickness of the rocks composing the Helderberg division, at different places in the State of New-York.*

NAMES OF ROCKS.	COLUMBIA COUNTY. Hudson.	ALBANY COUNTY. New-Scotland.	SCHOHARIE COUNTY. Schoharie.	ONEIDA COUNTY.	MADISON COUNTY.	OTSEGO COUNTY. Cherryvalley.	ONONDAGA COUNTY. Manlius.	CAYUGA COUNTY.	GENESEE COUNTY.	ERIE COUNTY. Blackrock.	Maximum thickness.
	Feet.	Feet.	Feet.	Feet.	Feet.	Feet	Feet.	Feet	Feet.	Feet.	Feet.
Red shale			80	500	700		500*				500
Green shale, gypseous rock & waterlime,	60	60	100			100	700*	700*	70†	40†	700
Pentamerus limestone	20	25	25			80	4				80
Delthyris shaly limestone	70	60	60			20					70
Encrinal limestone	30	10	10					1½			30
Upper Pentamerus limestone	3		4			1½					4
Oriskany Sandstone		2	2								2
Cauda-galli grit		60	60			10					60
Schoharie grit		4	4								4
Onondaga and Corniferous limestone		60	80			100			75†	50	100
											1550

* VANUXEM. † HALL.

The Onondaga limestone, the superior rock of the Helderberg division. The importance of this rock is seen in another and different point of view, namely, in forming a distinct line of demarkation between two divisions of rocks, which, though intended only as geographical lines in this instance at least, yet really defines the end of a series in the system. Lithologically the end of the series with this rock is indicated, though it could not be proved. If, however, organic bodies are permitted to speak, they tell us that such is the fact; for it is rare that those of this rock go up into the succeeding deposits, and still less probable is it that any of the rocks below the Onondaga limestone reach the shales and sandstones of the Erie division. This rock, then, forms or marks an era in the New-York system, which must always be regarded as important; and this is true, in whatever light we may regard this system; or whatever classification we may adopt, this rock must form the termination of one of the divisions. It is true that the upper portions are dark colored, and the layers are separated by seams of shale; still this only proves that the change which was about to take place was not sudden or immediate, but gradual. It is probable the dark color of much of the upper part of the Corniferous limestone is of the same nature as that of the Marcellus slate, the mass which reposes upon it.

On referring to what is said in the closing remarks upon the Champlain division, it will now be seen that we have at least two very satisfactory divisions in the New-York system: the first, ending with the gray sandstone of the Champlain division; and the second, with the Onondaga limestone. Between the lower division and the next succeeding, the Ontario division, the affinity or resemblance is only slight. There is, however, a greater resemblance between the Helderberg division and the Erie, probably, than between the former and the Ontario divison ; but as yet the relationship has not been fully stated, and perhaps it will be many years before it can be determined. The same limestone which is here described under the above name, is known and described in England under the name of Wenlock limestone. Ours probably resembles the latter as far as any two distant rocks can resemble each other. It is doubted by a few geologists, at least, whether any of our rocks can be considered strictly as identical with those of Europe. For this reason, it is proper, where the identity is not established, to give distinct names to the systems which are widely asunder, and especially when there is really such an amount of difference as there is now proved to be between the Silurian system of Mr. MURCHISON and the New-York system.

§ 9. SUMMARY OF THE PRINCIPAL FACTS RELATING TO THE HELDERBERG DIVISION.

1. The greatest thickness and most perfect development exists in Albany and Schoharie counties, or in the eastern part of the State.
2. The Salt group is developed only in the central part of the State.
3. The upper part of the Onondaga limestone is the most persistent mass ; it extends from near the Hudson river at Catskill to Blackrock, and maintains its importance throughout, though subject to variation in thickness.
4. The lower part is the reservoir of the salt springs, the gypsum, and the hydraulic limes, which are the principal valuable productions of this division.
5. The lower part of the Onondaga limestone is susceptible of receiving a polish, and may be wrought into mantle pieces, etc.
6. The agricultural characters are strongly marked and important, both in the inferior and superior masses, but less so in the middle.
7. The superior part is well defined, and the era of its deposit is clearly an important one.
8. The dip of the rocks included in this division, is conformable with the Ontario and Erie divisions : it amounts to thirty feet to a mile, and its general direction is south-west.
9. The surface of the country over which the rocks of the Helderberg division extend, is hilly in the eastern counties, but is comparatively a plain and level country in the western counties, or rather the hills are not so elevated. The ranges of hills have usually a north and south direction, and hence receive more sunshine than if they ranged east and west.
10. The gorges and waterfalls, though quite remarkable in this, are less so than in the Ontario division : they are formed mostly in the lower masses, the red slate and Onondaga-salt group, and the limestone shales of the Hydraulic lime series.

IV. ERIE DIVISION.

§ 1. General considerations in regard to the Erie division of the New-York system.

A fact of the highest importance, which has been ascertained in regard to the succeeding rocks, is that all the heavy beds of limestone are confined to the three inferior divisions that have been already described. Calcareous matter is disseminated through some of the lower members of the Erie division, and even strata of tolerably pure limestone occasionally occur ; still we consider it at least questionable whether any of these thin deposits should be treated as distinct limestone rocks. Should they be found to expand and thicken in the extension of the shales in which they here occur, in any direction so as to become in other places important masses, it would in that case be proper to treat them as rocks. Thus the Oriskany sandstone in New-York is quite thin and unimportant, yet in Pennsylvania it becomes an important rock. So the Tully limestone, when a more extended series of observations shall prove it an important mass elsewhere, will undoubtedly be regarded as a distinct rock. At present, however, it is only worthy of notice as a landmark, or as a deposit that serves to mark the termination of a group of shales ; as such it is important, and it is in some places important in furnishing lime. As a rock, or a member of a system, it only requires a passing notice, notwithstanding its fossils may be somewhat peculiar or limited to this mass.

The same remarks will be found applicable to another bed of limestone, that is sometimes associated with the Marcellus shales, the inferior rock of the Erie division.

The lithological characters of the rocks belonging to this division scarcely differ from those of the Hudson-river series. They are shales, brown, black, gray and green : the darker colored ones are mostly confined to the inferior part of the division ; the gray and green, to the middle and superior portions ; while the brown shale forms the superior part of the division. The gray beds often contain fine and beautiful flags, suitable for walks, window sills, coverings for cisterns and wells, and for a great variety of common purposes unnecessary to be particularly stated in this place.

The Erie division terminates above in a series of green and red sandstones and shales, which are known in New-York as the Fifth or Catskill division. The passage is gradual and indistinct, and hence it is not well ascertained where the division line should pass, or even whether the whole mass constituting the Fifth division might not with propriety be embraced in some general division of the upper members of the New-York system. This plan, however, though it is always desirable to limit the number of systems as well as rocks, will not probably be regarded as admissible beyond the bounds of this State, as the lines of demarkation are more clearly drawn in other parts of the United States and in Europe.

Another remarkable fact, and which ought not to be passed over without reference, is the absence in New-York of the important mass of limestone known elsewhere as the Mountain or Carboniferous limestone : its position is between the Chemung group and the Old Red system or sandstone. The absence of this limestone has deprived the southern tier of counties of an important rock, and which, if it had been deposited in its normal position, would have changed the agricultural character of these counties.

§ 2. Marcellus slate or shales.

I have already stated that the upper part of the Onondaga limestone is charged with black shaly matter ; that the rock itself is black from its presence, and that thin beds of shale appear between the layers. Such then are the indications of change in the rock. With the commencement of the black shale, the change appears complete. It is, however, chemically a mere predominance of silico-argillaceous matter over the calcareous ; for most of the rock, if not the whole of it, retains sufficient lime to effervesce with mineral acids. The lower part of the rock is more highly charged with lime than the upper, and this fact agrees with other circumstances that attended the deposition of the mass.

The Marcellus slate or shales may be thus described : Rock a slate, thin-bedded and fragile ; color black, and soils the fingers ; often exhales a bituminous odor when rubbed or broken ; undergoes an exfoliation when wet, by which process it breaks down into soil : calcareous matter disseminated throughout the rock. It would be impossible, from these characters alone, to distinguish this rock from the Utica slate, the shaly portion of the Trenton limestone, or the Genesee slate : its relations, and its fossils when its relations are concealed, furnish the only distinctive characters by which it may be known.

This rock has excited attention in consequence of its color, and also by its containing a small amount of coal : hence wherever its outcrop appears, numerous excavations have been made, under the expectation of finding this valuable product. It is scarcely necessary to say that all these attempts have failed : notwithstanding this, many persons are still confident that they will succeed in finding coal, provided they had the means of penetrating deep enough into the rock.

Relations of the Marcellus slate. It reposes upon the corniferous portion of the Onondaga limestone, from east to west, and along its southern outcrop, from New-Scotland in Albany county, through Greene and Ulster counties, to Pennsylvania. Above, it passes into the gritty and shaly portions of the Hamilton group. We have not yet been able to detect any change in the relations of this rock in its prolongation westward. In this respect it is an exception, as many at least of the rocks already described stand in connection with rocks in the western counties which are unknown at the east.

Places where this rock may be observed. The Helderberg range, which has become so universally known for its fine display of rocks, may be visited for this purpose. It is, however, concealed by its own as well as the debris of the succeeding rocks, in consequence of its fragile character. Hence, in fields, or other places unwashed by creeks, its outcropping slopes are often concealed by a thick mantle of its own debris. It forms the upper terraces in Schoharie, Carlisle, Cherryvalley, Springfield, Waterville on the road to Cassville, Madison and Manlius (where the highest hills are crowned with the Marcellus shales), Onondaga and Camillus, shores of Cayuga lake above Springport, at Aurora in Seneca county (a little distance south of Waterloo), on Flint creek two miles south of Vienna, at the outlet of Conesus lake, two miles south of the village of Caledonia, and on Allen's creek at Leroy. Still farther, and west of Leroy, at Alden, the upper part of the rock is exposed; but generally in this part of the State, the deep beds of drift and debris effectually conceal this rock from observation.

The southeastern exposure of the Marcellus shale, from the northern slope of the Helderberg to Ulster county, furnishes but few localities of much interest. Upon the hills, or rather low mountains west of Leeds or Catskill, Saugerties and Kingston, this rock occupies the first distinct terrace, but the debris conceals the strata too much to permit us to observe the connections or the fossils.

Septaria. The Marcellus slate is the first rock which contains those concretionary bodies known as septaria. These oval and sometimes round bodies are impure limestones, the materials of which were deposited along with the shaly matter; but in consequence of the play of affinities, the calcareous part separated from the great mass of shaly matter, and the molecules combined to form the bodies under consideration. During the process of drying, the argillo-calcareous matter shrinks and cracks, forming thereby septa which radiate from the centre and terminate in the circumference: these are subsequently filled by infiltration, either of calcite or the sulphate of barytes or strontian. In the formation of septaria, we are furnished with a beautiful as well as a striking illustration of a series of molecular changes, which the strata may and do undergo during the process of solidification; and indeed we may be well assured that even the solid strata are continually undergoing extensive changes, in consequence of the ever active and energetic forces with which matter is endowed. Hence it is important, in speculating upon the conditions of strata, to bear in mind the fact that matter is never quiescent; never reaches that dead point where it is destined to remain stationary. Freedom of motion is found in fluids: in the tenacious clays, the particles are freer than in the granite of the mountains; but even here they feel the force of molecular attraction, which results in regularity though not in stability of form; for heat and cold must continually modify the shape of the particles, by altering the saliency of their angles.

Limestone stratum associated with the Marcellus slate. At Schoharie, Cherryvalley and Manlius, a black limestone, from five to ten feet in thickness, occupies a position in the midst of the shales. It is an argillo-calcareous rock, and probably is capable of forming an excellent hydraulic mortar. It weathers out into extremely rough masses, so that persons who have occasion to work the rock generally call it *chawed rock.* In the Helderberg, this mass is concealed by debris, if it exists there; and it is not distinctly recognized in the western counties. The composition of this limestone does not differ materially from that of the septaria; and probably the latter will increase in value and importance, when it is known that they make the true Roman cement.

Thickness of the Marcellus slate. As this rock is not clearly defined in its upward passage, but is merged in the dark grayish shales of the Hamilton group, its thickness is not determined. It is probably not less than one hundred feet at Schoharie and Manlius; in the middle and western counties, it hardly exceeds fifty feet.*

Agricultural characters of the Marcellus slate. The chemical constitution of this rock, and the ready conversion of its materials into soil, confer upon it important and useful adaptations to agriculture. The rock, especially the lower part, effervesces with acids; and hence the calcareous matter is in sufficient quantity to influence the soil favorably, and fit it particularly for wheat. In addition to the lime, it also contains carbonate of magnesia, which, by its presence, adapts the debris of the rock to the culture of maize. Observations upon the region where this rock prevails, confirm these statements. Where there appear to be exceptions to them, it will probably be found to arise from height, or some physical cause independent of composition.

§ 3. Hamilton shales.†

It is difficult to ascertain the point where the Marcellus slate ends, and the Hamilton shales begin; partly from the circumstances under which we are obliged to make our examinations, and partly from the similarity of the masses themselves. The Marcellus slate becomes sandy, and loses its dark color, as well as its slaty character, and is consequently merged gradually into the shales which succeed in the ascending order. The Hamilton shales, however, are limited above, or superiorly, by a dark colored mass which has been called the Tully limestone. This would seem a sufficiently distinct limit, if the limestone extended eastward; but as it is absent in the river counties, and scarcely extends beyond the central counties in this direction, the group is still left without a distinct line of demarkation in nearly one half of the State. We are, therefore, obliged to resort to a careful study of its fossils, in order to define the limits which the mass occupies.

However this may be, we have, with this group, entered upon a series of rocks which are in the main siliceous, and in which very little calcareous or magnesian matters are to be found; and hence it is that the agricultural capabilities of those sections of the State, where these rocks predominate, are also changed. The masses composing these shales, as

* Hall's Report, p. 159.

† I have changed the word *group* into *shales*, as will be seen by the several reports on the rocks of Central and Western New-York The change seemed to be called for, as the name now expresses the character of the masses to which it is applied. In accordance with this view, I have frequently used the denomination *Marcellus slate* as also expressing the nature of this rock. It is, however, to be understood, that the word *slate*, or *shale*, is always applicable to a mass which may fall under our examination; for there are some slates in the Hamilton rocks, and the upper part of the Marcellus slate becomes a shale. The difference between a slate and shale simply is the predominance of sandy materials in the latter over the argillaceous. In consequence of the excess of sandy matter, shales are thicker bedded than slates. The two kinds of rocks, however, run into each other by insensible gradations, especially when the grains of sand are fine.

we have just observed, are sandy ; but they are often interlaminated with thin soft slate of a bluish or greenish color, and all its beds, as a whole, are thin, but rarely even-bedded. The particles too are usually fine, and it is exceedingly rare to meet with coarse conglomerates ; though near the superior part of the group, a few thin pebbly beds are sometimes observed, and seem to occupy pretty constantly a uniform position.

Lithologically the Hamilton shales resemble those of the Hudson river. They are usually gray, but sometimes brown from weathering — some beds particularly so towards the top of the series.

Imbedded or associated minerals. It can hardly be said to furnish any minerals. The beds are rarely (if ever) even sparry in this State. This arises from the perfect quietude which prevailed during the deposition of the beds, and the slight fractures which they suffered at the time of their elevation. The only indication of foreign mineral matter which this group discloses, is a thin band of impure carbonate of iron which is occasionally seen in the upper beds.

Relations of the Hamilton shales. The relations of this mass are nearly the same, both eastward and westward. It reposes every where upon the Marcellus slate. Superiorly the Tully limestone seems to be wanting in Schoharie and Albany counties, and hence in this direction the line of demarkation is not well defined. The shales run into, and are imperceptibly incorporated with, the next series of rocks, which are known abroad by the name of *Devonian*, and in this State by that of *Portage* or *Chemung*. To the west, as has been remarked, the series is restricted by the Tully limestone. It may be that this restriction is too artificial and arbitrary, inasmuch as the same mineral characters are preserved, and also some of the fossils ; and it is hardly possible to find any where those physical changes which sometimes appear, and mark the introduction of a new epoch. Some of the beds, towards the upper part, are less regular, more concretionary, and appear as if they were deposited under a slight change of circumstances, such as would occur if a change of level had taken place in the bottom upon which the former materials had been deposited.

Agricultural capacity of the Hamilton shales. We are now introduced into a region, whose capabilities in production are decidedly of a different kind from those of the limestone shales that have been already described. This change is due to the constitution of the rocks mainly, although we have no doubt that height, configuration and slope, may modify to a certain extent the productive capabilities of the region over which these rocks extend. Agriculturally they closely resemble the Hudson river rocks, and we may perhaps say with truth that this resemblance is no less than that of their lithological characters. Both series are remarkably destitute of calcareous matter, and both are distantly associated, if the expression is proper, with limestones below. Thus the Utica slate resembles the Marcellus slate : both are somewhat calcareous, and both succeed heavy beds of limestone, which constitute important landmarks or wayboards for the determination of series and groups. In the Hudson river shales, a few bands of limestone, highly fossiliferous, ap-

PLATE VI.

ENDICOTT'S LITH. NEW YORK

MOESTACRA, OR VROMAN'S NOSE,

Schoharie Co.

pear towards the end or about the middle of the series. So in the Hamilton shales, impure calcareous bands are met with, though the calcareous matter seems to have been derived from the petrifactions which they inclose. This shows that some calcareous matter existed in solution in the waters from which these rocks were separated or deposited; indeed, the shales sometimes effervesce feebly. Now the main peculiarity which we find in these rocks, consists in the ability to produce good pasturage: the soil possesses that light character which fits it for sweet grazing. There is always seemingly sufficient alumine or clay in these rocks to give the debris the proper consistency to hold water, and this rarely to excess. There are two other circumstances which contribute to form a grazing country where these rocks predominate, namely, sweet or pure water, and a hilly surface. The water, under such circumstances, drains off rapidly, and leaves the soil refreshed: it will not stagnate above or beneath the surface. If the grass and herbage is not so luxuriant, it is sweeter, and promotes the health of the animals which feed upon it. The atmosphere circulates freely over the hills and through the valleys, and thereby rapidly renews the essential elements of life and activity.

Succession of strata and illustrative views. The succession of the groups and strata are well exposed on Cayuga and Seneca lakes, and in the valley of the Schoharie (See Plate xxi., sections 3 and 4; or Plate xx., sections 2, 4, 5 and 6). For illustrative views, see Plate vi., which may be compared with Plate iv.: the formations of the former are undisturbed, while the latter is on a zone or belt which has been broken up by internal convulsions.

Thickness of the Hamilton shales. It is difficult to obtain the data from which the thickness of this rock can be determined. By estimating the fossiliferous and non-fossiliferous parts by themselves, and summing up the result, we obtain from 1000 to 1200 feet thickness. In the eastern part of the State, in Albany and Schoharie counties, the thickness appears to be much greater than in the western counties; at the same time it must be acknowledged that the line of demarkation between this and the upper part of the Erie division is indistinct, and hence masses which belong properly to the Devonian or Catskill rocks may be included. The lower part of the Hamilton shales are destitute of fossils in Schoharie county, for about fifty feet: then we meet a band of fossils, among which is a *Conularia* and *Posidonia;* this is succeeded by another non-fossiliferous band of considerable thickness, and then fossils again occur; and in the Olive shales, so called, the fossils are very numerous, and among them we find a great abundance of the *Delthyris mucronata*, the beautiful *Orthonata undulata*, and *Dipleura dekayi*. Still higher in the series, we find an abundance of vegetable fossils, which extend through beds of sandstone and shale for sixty or seventy feet; and lastly, in the tops of the hilly region of Fultonham in Schoharie, the rock becomes a grayish sandstone, with stems of plants, encrinites, and a large delthyris. In the hills of Fultonham, the thickness of the superimposed masses is at least eight hundred feet. The beds are thin at the base, but not even-bedded; at the summit, they are thick and more even, though a band of contorted sandstone appears two hundred feet below the top of the mass.

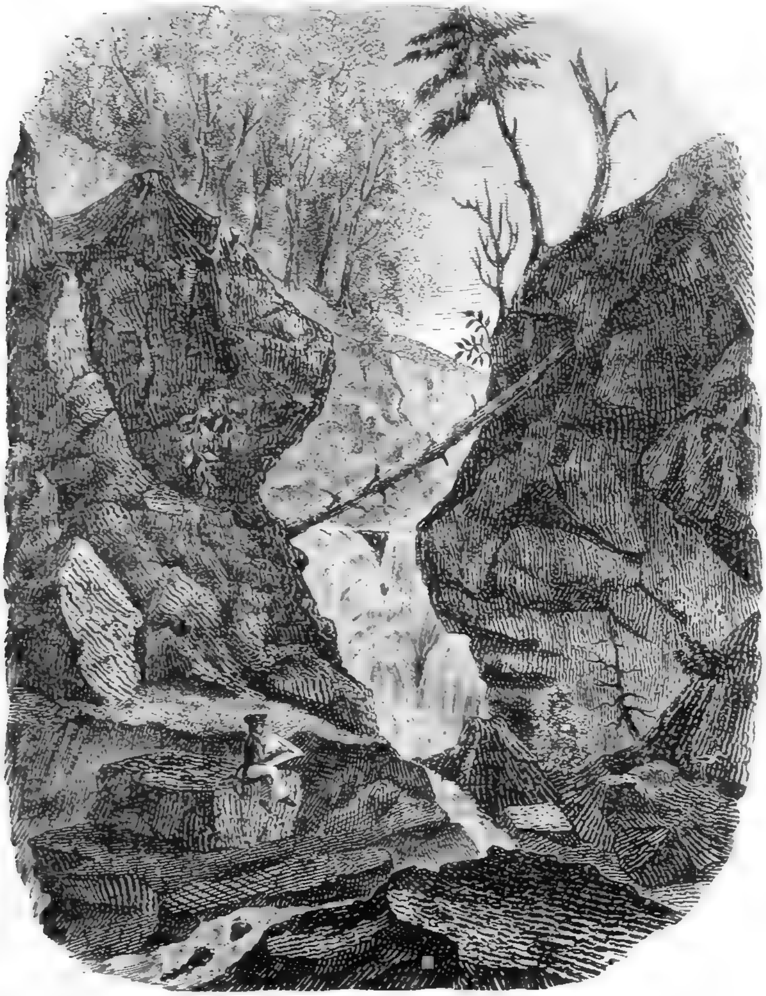
The view of the head of the gorge at Summit, is only one instance among many of the wearing action of the streams. Upon this series and range of rocks from the Hudson to Lake Erie, all the water courses cut through the shales and sandstones of this group. An interesting fact is well worthy of notice in this place, namely, that as the New-York sedimentary rocks are composed of hard and soft materials, the whole series seem to be cut through from the Potsdam sandstone to the top of the Erie division. The aggregate amount of the perpendicular falls of the streams which flow over the series, is not less than one and a half miles, from the top of the Catskill series, to the base of the Potsdam sandstone.

§ 4. Tully limestone.

Towards the top of the series composing the Hamilton group, calcareous matter increases; and in the central counties, it is so far increased that a compact black limestone has been deposited. In Albany and Schoharie counties, it is unknown; neither has it been noticed west of the Genesee valley, and yet beds of a black limestone occupy its place at Moscow above the Moscow shales. These layers or strata are compact, black, bituminous, and interlaminated with shale. They contain a few fossils, the most interesting of which is a microscopic orthoceratite; and all the remains are extremely minute, but very numerous.

The thickness of the Tully limestone is from twelve to fifteen feet: hence the mass is too inconsiderable to exert an influence upon the soil. The rock is exposed upon the west shore of Cayuga lake, and the eastern shore of Seneca lake near Hathaway's landing; also at Bellona in Ontario county, and the outlet of Crooked lake. At Bethel on Flint creek, it forms a part of the banks; while four miles northwest, it is only three feet thick. Farther west, on Canandaigua lake, it is represented by a few inches only of impure calcareous rock. West of this lake, according to Mr. Hall, it is virtually absent, although its place is indicated by bands of calcareous shale.

View of the Head of the Gorge at Summit.



V. CATSKILL DIVISION;

OR OLD RED SANDSTONE OF THE NEW-YORK REPORTS.

DEVONIAN SYSTEM (IN PART) OF ENGLISH AUTHORS.

So far as agriculture depends on the composition of the soil, the separation of the rocks below the Tully limestone, from those above, is of but little consequence. There is throughout a great preponderance of sand in these rocks; but this element is modified by alumine, even in the thick-bedded sandstones, and more especially in the thin beds of shales and slates with which the beds of sandstone alternate.

Geologically this is an interesting part of the New-York series. It forms by itself a distinct system, and has been described by Mr. Phillips under the name of *Devonian system*. It is designed to embrace not only the peculiar rocks of Devonshire, but those of Scotland, and of places on the continent, which have hitherto been known and described under the name of *Old Red sandstone*. Comparing our rocks of this division, however, with what we know of their equivalents in Europe, we find that they present a different phase; reserving, in this expression of opinion at this time, the right to change our views from time to time as discoveries may progress. In Scotland, for instance, the Old Red sandstone contains many fishes of remarkable forms; but in no place in this country, where this rock is even well developed, have these interesting fossils been found. Here, conchifera, associated with a few fishes, seem to characterize the rock; and these are confined to the lower beds, the upper ones, so far as discoveries have been made, being destitute of animal remains. Some land vegetables, belonging to three or four species, run through the system. In this country, whatever differences may have been observed between the Hamilton shales and the masses intervening between them and the Coal series, there is no where a sudden transition by which we pass at once from the Silurian to the Devonian system, either in fossils or in mineral matter: there are no disturbances, which could have broken the general quiet of the period during which this great series was being deposited. At a few points, inconsiderable movements may be observed, affecting slightly a portion of the deposit; but the same observation applies equally well to the Hamilton shales, and the Helderberg division. The physical changes which seem to have occurred during these periods, were merely gentle oscillations, destitute of violence or rapidity. Hence these rocks repose in unbroken strata; or, if broken, the change of position amounts to a few feet only; or it is of such a nature as to have resulted in gentle flexures, along which the layers remain unbroken. The mass has received, as a whole, that slight movement by which the layers have been placed in a position inclining to the southwest at a very moderate angle, a position which was given them when the great central primary mass north of the Mohawk valley emerged from the Apalachian sea.

§ 1. Portage and Chemung groups of the Genesee valley.

The Moscow shales represent the Hamilton group in this valley. The rock is a light green, soft and fragile. A black slate, interlaminated frequently with thin beds of black limestone, succeeds the Hamilton shales both at Moscow and Geneseo. The change in the mineral constitution of the rock is accompanied with a change also in fossils; and, as has been stated, microscopic orthoceratites abound in the layers which immediately succeed the Moscow shales; while, at the same time, all the characteristic fossils, without exception, belonging to the last mentioned rock, remain below. Fossils, then, in this valley, and in this series, determine where one group ends and another begins. We are not, however, furnished with distinct lines of separation in the vicinity of the Catskill and Helderberg ranges, as we shall have occasion to show in the sequel.

Genesee slate.

The first mass above the Moscow shales is the Genesee slate: it is usually colored black, but often stained brown upon the outside by decomposing pyrites. Its laminæ separate easily, and fall to thin pieces of the size of a penny; forming, by this kind of disintegration, a flat gravel. The whole mass is bituminous. Its fossils are peculiar, but few in species; yet it is not improbable that, if fresh deep cuts were made, it would be found largely supplied with them. The exposure which results from weathering, obliterates fossils especially when they are obscure or small.

The lower part of the Genesee slate consists of strata or laminæ of thin slate, alternating with thin-bedded compact black limestone. The thickness of the strata of limestone varies from three to eighteen inches. These beds of limestone continue upwards at least one hundred feet, when they disappear: above this, for three hundred feet more, the rock continues a black slate; and after this it becomes shaly, or changed into a mass in which slate alternates with thin-bedded sandstone. The thin laminated masses continue onwards to Portage; and even at the Lower falls, the flags are thin-bedded, and alternate with a black bituminous slate, indistinguishable from the Genesee slate at Mountmorris. The strata undulate, or form short curves, which coalesce like those of the slates of the Hudson river.

Thickness of the Genesee slate. If, as we suppose, this slate succeeds the Moscow shales, and if it forms the cliff at the fall near the village of Moscow, it is at least four hundred feet thick. This we consider as an under estimate, rather than an over one; for, at one place near Mountmorris bridge, the exposed part is three hundred and forty feet above the river. At the same time it is not improbable that undulations may exist, which must in that case be set off against the dip, which amounts to fifty feet to the mile at a few points where it is susceptible of measurement.

Localities where the Genesee slate may be observed. The most important locality has already been noticed, namely, the great gorge above Mountmorris, through which the river flows. We remark, however, that calcareous bands are numerous in the lower part, and that the middle and upper portions are interlaminated with shale. Proceeding east, it may be observed on Cayuga lake, south of Ludlowville, supported by the Tully limestone; at the falls of Lodi, and the outlet of Crooked lake. It forms the base of the hills of Deruyter in Madison county, and those of Fabius, Truxton and Preble. At all these places it is succeeded in the ascending order by gray flags, as in the gorge of the Genesee. On Lake Erie, it is well exposed and well characterized by its fossils at Eighteen-mile creek. Between Lake Erie and the Genesee river, it is exposed in ravines which open to the north.

As a general guide to the position of this rock, and the localities where it may be observed, the student may take advantage of its position above the Hamilton shales, and its general east and west range from its position at Moscow and Mountmorris.

Thickness of the Portage group. The Portage group, as it exists in the cliffs and gorges at and below Portage, is mainly a gray sandstone. So gradual has it changed from a thin black slate to a thick-bedded sandstone, that it is useless to attempt to draw division lines between the lower and upper strata. Drawing, then, an arbitrary line along the strata, near to a plane where the Genesee slate seems to terminate, or where the rock has ceased to be a decided slate, or has become a thin flagstone, and then including in the Portage group the whole mass above as it exists at Portage, we believe the thickness is not far from twelve hundred feet. But Mr. Hall, who has had better opportunities for determining this question, has estimated it at one thousand feet. It must be recollected, however, that the cliffs from Mountmorris to Portage maintain an elevation of three hundred and fifty, and perhaps four hundred feet in some places, and that the dip is at the rate of about fifty feet to the mile.

Gorge in the Portage group. At Mountmorris the Genesee river issues from a gorge, which is remarkable both for depth and length. It is in this deep cut, made by the river, that these rocks may be observed to the best advantage. At the bridge near Mountmorris, steep and even perpendicular cliffs bound and shut in the river on both sides. These cliffs, in consequence of the increased thickness of rock, rise up above the river three hundred and forty feet on both sides. With these formidable banks on either hand, the river wends its way from Portage. A part of the distance there is space for a road; but the descent to the river is practicable in a few places only, while most of the distance it is totally out of the question. The slate is the only rock which forms the cliffs for four or five miles towards Mountmorris; and the character of the mass, as indicated above, is preserved. The first change which appears, is produced by an increase of silex or sand. The layers are still thin; but in the place of argillaceous layers, thin undulating shaly ones appear. If we trace the changes as we proceed towards Portage, we find the sand still increasing, and the strata becoming thicker, till finally at Portage the formation has become a thick-bedded sandstone. It is a gray fine-grained rock, and works well under the chisel; and, when wrought, it is durable. Some exceptions, however, ought to be made: the masses must be free from slate, in order to resist the action of the weather.

§ 2. PORTAGE, ITHACA AND CHEMUNG GROUPS OF THE CENTRAL COUNTIES OF NEW-YORK.

The Chemung group is made up of flags and slates, whose beds are thinner than those of the Portage group upon which they rest. The flags are gray, olive and brown, with impure calcareous bands of fossils; the shales are green and olive, but sometimes black. These forms of mineral matter are arranged without order. The stratification is usually

Fig. 31.

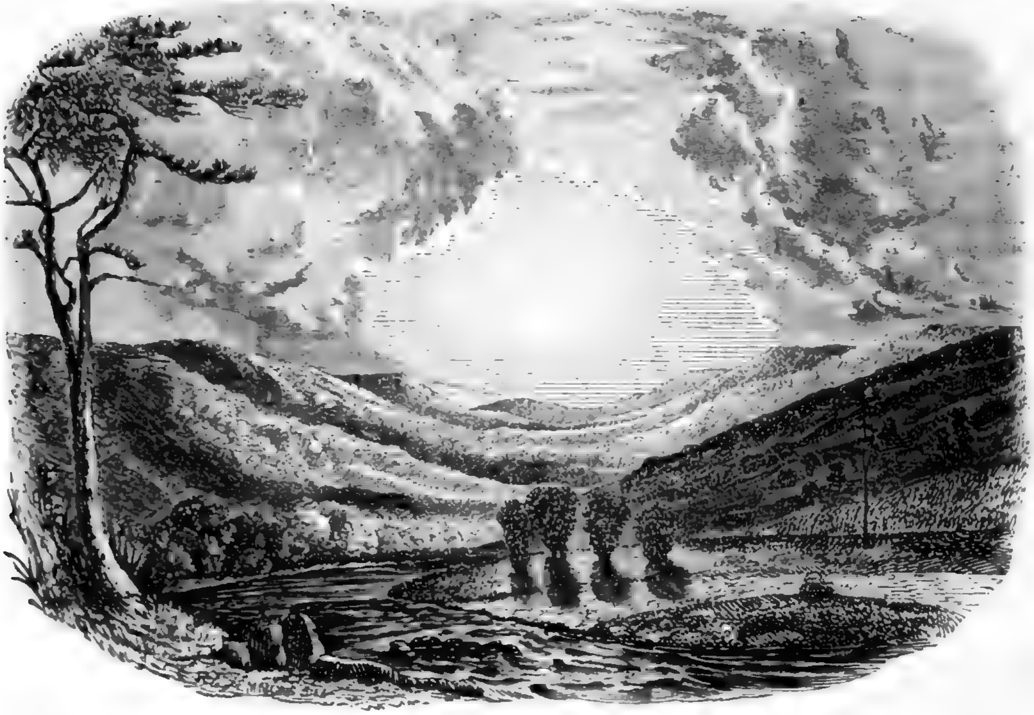
distinct: in the upper part it is diagonal, a fact which may be used for determining the position of this mass at distant points. The diagonal stratification (fig. 31) prevails in the Catskill mountain rocks, but has not been observed below the Chemung group.

At Ithaca and Cortlandville, the lower part of the Chemung group is represented in the green slates and flags. At the former place they are exposed in the cuts of the inclined plane, while the Portage group is below, rising from fifty to one hundred feet above the lake. At Cortlandville, the Ithaca group is exposed in the quarries about half a mile south of the village. The same species of fossils have been found here as at Ithaca, namely, the *Microdon bellistriata;* a flat coral; an ornamented univalve, which appears to be a *Murchisonia.* The series ascends to Virgil. Here is a full development of the Chemung rocks. It would seem, from a comparison of facts developed by a careful examination, that the Ithaca group is not equivalent to the Chemung as it is developed at the Chemung narrows; but rather that is beneath, and situated between the Portage and Chemung groups. There is, however, no necessity for separating the Ithaca from the Chemung group: it is more simple to regard the masses as parts of one series, in which the inferior and superior may differ in many points. According to this view, the rocks of Virgil and Chemung belong to one and the same age, and those of Cortlandville and Ithaca to another; and this view is borne out by the fossils collected at both places.

Springs and mineral contents of the group in the central counties. The springs which issue from the upper part of the Chemung rocks, are comparatively pure; those of the Genesee slate, may be bituminous. In a hilly region, numerous streams, originating in springs, are expected; in the valley of the Genesee, however, adjacent to the great gorge, very few exist. The traveller, passing over the fine road from Mountmorris to Portage, will be surprised at not meeting more than one or two small streams the whole distance. This scarcity of running water is a great inconvenience to farmers, inasmuch as frequently it is difficult to procure water for cattle. Cisterns and wells are the only modes left for furnishing a supply, which of course becomes precarious in dry seasons. The nature of the rocks, their porosity, and especially the deep cut of the Genesee river, combine in their effects to produce a very thorough draining of a very wide extent of country on both sides of the gorge. Still where there is a deep soil, upon a surface only moderately steep, the drainage is not so perfect as to lay the upper parts dry; and where a clay forms the subsoil, draining in the usual way may still be required.

The minerals of the group have no claim to a special consideration: pyrites, in the shale, is the most common; it is the source of the chalybeate waters, wherever they exist in the formation. Its presence aids the decomposition of the slates, facilitates first their disintegration, and finally perfects those changes which end in a thorough separation of the elements of the rock.

View in Gilboa.



§ 3. Portage, ithaca and chemung groups in the schoharie and hudson-river districts.

The development of the Hamilton shales is excessive in the eastern part of New-York, but there are only slight differences in the lithological characters. At Summit in Schoharie county, in a deep gorge near the village, the Chemung group occupies the upper part and the higher slopes adjacent to it, and also the hills above the village. As yet, however, the fossils of the Chemung narrows are not common or numerous; and it seems to be established that the fossils of the Hamilton shales go up higher into the shales and flags, and occur nearer to the base of the Catskill division or Old Red sandstone, than at the west. The flags at the top of the Helderberg range, and the rocks occupying the highest position in the southern towns in Albany and Schoharie counties, belong to the Chemung group.

The purposes of agriculture do not require an identification of the rocks under consideration: they belong chemically and mineralogically to the same class. The structure, the tendency to decomposition, and the soil which is formed by disintegration, does not differ essentially in Albany county from that of Allegany or Cattaraugus county. We do not find the exact equivalents when they are tested by fossils: it is possible, however, that this may be owing to exposure. Other fossiliferous strata than those, for example, which are exposed in Chemung, may be exposed in Schoharie and Albany counties, or in the rocks of the eastern part of the State. Where fossils are limited to narrow bands, and where their vertical range is small, corresponding strata at two distant points may be concealed at one or the other. The kind of distribution alluded to, is that which prevails. A stratum from two to twelve inches is loaded with fossils; but above or below for fifty or one hundred feet, they are either very scarce or do not exist at all. This is the general mode in which they are distributed in thick beds, sandstones and flags, a mode which does not seem to prevail in calcareous shales and limestones. In these deposits, it is not uncommon to find organic bodies distributed throughout the whole mass.

Localities where the sandstones and flags described above may be examined. Many localities have already been mentioned, at which the strata are well exposed, and afford opportunities for observation. At Portage, and at points intervening between it and Mountmorris, many interesting and important facts are disclosed in the deep gorges. All that relates to the power of moving water in excavating rocks, the nature of the rocks themselves, their stratification, etc., are displayed to great advantage. Few fossils only are found, and those not of the most interesting kind. Bodies called *fucoids*, and which are referred to a class of marine plants, are common. The same are common at Deruyter, Homer, and in the hills in the same geological range for a wide extent east and west of the points named; also in Oneonta, Harpersfield, Summit, Rensselaerville, Virgil and Ithaca. Most parts of the counties of Tioga, Broome, Allegany and Chautauque, are mainly underlaid by this series of rocks.

Agricultural characters of the shales, flags and sandstones of the Portage and Chemung rocks. This is not the place to state, with any degree of particularity, the relations which these formations bear to the capabilities of the soil derived from them. They have, however, characters of their own; that is, peculiarities which distinguish them from calcareous and limestone formations. The greatest chemical difference is found in the absence of lime, except where it is derived from strata at a distance. When the soil is first broken up, some lime may be found; but cultivation, and the exposure which a cultivated surface suffers from percolation of water, soon removes the calcareous matter. The soil is then a silico-aluminous one, and may in some places be a stiff hard soil; in others, the predominance of sand gives it a character directly opposite. The full consideration of the soils of these rocks will come up in another place, where they can be treated in connection with those of other parts of the State.

§ 4. Catskill group.

Mr. Vanuxem describes these rocks as consisting of light-colored greenish gray sandstone, usually hard; of fine grained red sandstone, red shale or slate; of dark-colored slate and shale; of grindstone grit, and a peculiar concretionary or fragmentary mass composed of shale principally, cemented by lime. The mass referred to in the last place, varies in thickness from a few inches to two feet, and, from its nature, may be regarded as characteristic of this part of the New-York series. Certainly it is not observed in any of the lower rocks; and as it is a very constant mass, and widely extended, we deem it a valuable wayboard by which position may be determined with a good degree of certainty. This mass, too, it may be important to say, is regarded by Mr. Vanuxem as equivalent to the cornstone of the Old Red sandstone.* It appears quite early among the strata, and goes up to the middle of the series. We have not been able, however, to connect our observations together so as to be satisfied that such is the fact, or that it does not extend farther than the central part of the rock. We believe it belongs to the inferior part, and may be sought for the purpose of identifying this part of the group. The diagonal stratification is another peculiarity of the rock, which has been referred to already. It is spoken of by Mr. Hall, as appearing in the upper part of the Chemung group. The difficulty, in New-York, of defining the limits of groups, is such that it can not always be made clear where one begins and another ends. Hence it may be true that this part of the so called Chemung group might, with great propriety, be referred to the Catskill division.

The great body of materials forming the Catskill division, are grits, alternating frequently with olive-colored shales, red slate, or red marl. The latter is sometimes from thirty to fifty feet thick; yet there is less of red rock than is generally supposed, or less than is implied in the old name by which this rock has been distinguished. The name *Old Red sandstone*, or *Red system*, would lead to the inference that it is a red rock mainly; whereas only about one-third of it is red, the rest being a dark slate, or greenish or grayish flagstone. Originally the color of the slate was olive or green, throughout the series of beds: it is by atmospheric action that the slates and shales have changed their primitive color. This process is still in progress; and the darkish green rocks, on breaking down, assume first a brownish tint, and then a red one, capable of staining substances with the same color, an effect due to a change in the oxide of iron, which in the green slates is a protoxide, but by a further acquisition of oxygen becomes the peroxide.

The engraving on page 192 is a view of the Schoharie creek at Gilboa, on the road from the village leading to the Manorkill falls: it looks south. All the ranges which close in upon the creek, and bound its valley, belong to the Devonian system.

Dip and stratification of this series. To the eye within a distance of a few feet, the rocks appear horizontal; but when viewed at a considerable distance, or from a point where there is a sufficient range, they indicate a dip to the southwest, less, however, than the New-York rocks are known to exhibit at distant points; yet this remark applies to the series which form the body of the Catskill mountains. At the base, especially on the eastern slope, the dip is quite steep; at least it is decidedly marked even in the outcrop of the cliffs which terminate the successive terraces. The stratification is no less regular than the dip: at the base, the strata are parallel; at the middle, and towards the summit, the diagonal stratification is common.

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* Vanuxem's Report, p. 186.

PLATE XII

Termination of the strata. The conglomerates and coarse grits above the Catskill Mountain House, have been referred to the Coal series, and this is probably right. In Chautauque county, beds of conglomerate, apparently occupying the same position, are referred also to the same period.

Strata at Gilboa. An interesting locality of the Catskill division exists at Gilboa. A good section is exposed by the Manorkill, a creek which flows from the east, and falls into the Schoharie creek near the village. The lowest rocks on the creek are,

1. Four feet of green fragile lumpy shale.
2. One foot brown hard compact sandstone, blotched with green.
3. Two feet red slate, alternating with one or two feet of green shale.
4. Ten feet of gray sandstone.
5. Three feet of black shale.
6. An undefined mass of gray sandstone succeeds, which contains land vegetables, and, at the Manorkill falls, one mile above the village, also contains numerous fossils, among which are several *Cypricardia*, two species of *Solen*, and what appears to be the *Terebratula lepida*.

The rocks are coarse grits at the falls, with some layers of green tough shale, in which are contained most of the *Cypricardia.* The tough lumpy character of this shale is a great inconvenience to the collector of fossils. Above the Manorkill falls, the red marl or slate is many feet thick. This is succeeded by the greenish and coarse sandstone shales alternating for five or six hundred feet, and appearing in high and steep escarpments on the mountain half a mile north of the kill: the rock contains a few *Cypricardia.* The whole series is fossiliferous; more so, we think, than what appears upon a cursory examination, principally on account of the coarseness of the grits and the unfavorable state of the stratification. The beds at and immediately above the bank of the creek near the village are destitute of animal remains, or at least we did not succeed in finding any. Now the stratum which contains vegetables at other places, contains also *Cypricardia.* In this stratum, many fragments of stems and long leaves are preserved, but crushed, and so broken that they are worthless as cabinet specimens; yet the stratum itself is a good guide for the rock. It is the same as that described in Mr. Vanuxem's report, in which he first discovered the fossils at Mount Upton on the Unadilla. The discovery of this stratum (or strata, for there are several) at Gilboa, at the base of adjacent mountains, identifies two distant series, and proves their equivalency and age.

Continuation of the strata to Prattsville. The coarse grits continue to Prattsville; and though often concealed by debris along the banks of the Schoharie creek, yet a glance at the cliffs of the adjacent hills will be sufficient to settle the fact that the strata of Gilboa continue uninterruptedly to Prattsville; and as but little progress is made towards the south, or in the direction of the dip, we may feel satisfied that we gain but little in height. This is important to be borne in mind, for it has been said that the rocks of Gilboa belong to the Hamilton group, and as fossils closely resembling those of this formation were discovered six or seven hundred feet at least above the locality on the Manorkill, where

Devonian fossils had been found, it became important to accumulate as many facts as possible which would bear upon the question; and we were fortunate enough to discover the remains of fish in the strata between Prattsville and Gilboa, and, what was still more satisfactory was their association with the *Cypricardia catskillensis* discovered by Mr. Vanuxem on the Unadilla. These fossils will undoubtedly be found quite numerous in this neighborhood, as we observed several specimens in the rock two miles above Prattsville, on the banks of the creek. It appears, therefore, that it has a wide range in this series, and may be regarded as characteristic of the formation in which it is found.

Series at Jefferson. Here the rocks exhibit the same character as at Gilboa and Prattsville. They are flags, some of which are quite thin, and they are interlaminated with black slate. At this place, near the village, we discovered the same fossils as those of Gilboa, namely, the *Cypricardia*, *Tentaculites*, *Orthis*, etc. Besides the strata of crushed vegetables and the diagonal stratification already mentioned, Mr. Hall has discovered a scale of the fish characteristic of the Old Red sandstone. In these discoveries we have the facts which have settled the character and age of the rocks in the southern part of Schoharie, Albany, and those of Greene and Delaware counties. They form one series of rocks, which may be traced south, southwest and west, through the southern tier of counties; and as a few fossils of the Chemung narrows have been found in Gilboa, we are able to connect the series with distant points west. The Chemung group, which had been supposed to be confined to the southwestern counties, has been proved, by the discovery of fossils, to occupy a place also at the base of the Catskill series. Of the *Dipleura dekayi*, *Microdon bellistriata*, *Cypricardia angulata*, the latter is credited to Chemung narrows, while the two former are well known Hamilton fossils: these, with several others, occur five hundred feet above strata which have hitherto been regarded as belonging exclusively to the Catskill series. Facts of this kind may lead us to distrust the value of our lines of demarkation between the groups of a system.

Agricultural characters of the Catskill series. The soil is colored red, when derived from the Catskill rocks. The red marls form a soil very well compounded of sand and clay: it derives an advantage from its color. Red soils are warmer and earlier, yet they do not bear drought so well as the brown and yellow loams. The soil of these rocks may be regarded as light; and being deficient in lime and alkalies, it is not so productive at first, nor so durable, as those of Onondaga and Cayuga counties.

Localities where the Catskill series may be advantageously examined. These rocks may be reached by two routes: 1st, that of the Mountain House or Pine Orchard; and 2d, that of Schoharie creek. The Mountain House route leads over part of the Champlain, the Helderberg and the Erie divisions. The Hudson-river series, and the whole of the Helderberg series, are finely exposed, but in an interesting state of disorder. The Erie division is tilted up, but not materially crushed or dismembered; the angle of dip continually diminishes from the Hamilton shales upward, each ascending terrace being disturbed less and less as it is distant from the belt of disturbance, passing between the Hudson river and the village of Madison. This is a short and interesting route, but not so favorable for collecting fossils. The second route, that of the Schoharie creek, begins at Schoharie Court-house, and follows it up to Gilboa, Prattsville, Lexington, Hunter, and then to the Catskill Mountain House. The whole New-York system is traversed by this route, and it leads up a beautiful valley, on the sides of which the strata are finely exposed in receding terraces or steep escarpments. Beautiful cascades and splendid scenery gratify the sight at every turn; while to the geologist the succession and stratigraphical arrangement is so clear and satisfactory, that all doubts are dispelled. The advantages of this route are decisive, in consequence of the fine field at Schoharie, where the succession is over a complete division of the Helderberg rocks: the Erie division is full and complete also, and may be observed first in the rounded hills about Schoharie village, dipping in the direction of the route up the creek; and the succeeding members slowly follow each other, till, finally, at Gilboa, the Catskill rocks are found at the base of the high ranges which have hedged in the creek for twenty-five miles. The route will be completed by descending on the eastern side by the steep road of the Mountain House, which leads over the belts of the disturbed rocks that have been already noticed.

Thickness of the Catskill division of the New-York rocks. The strata rise horizontally, or nearly so, from Gilboa to Conesville. The latter place is the highest travelled point between the former place and Catskill. It is twelve hundred feet above Gilboa, or two thousand feet above tide. The mountains rise over one thousand feet above Conesville. The rocks belonging to the Catskill division are between eighteen hundred and two thousand feet thick.

Illustrative views. The clefts through the mountain ridges furnish an exceedingly rich scenery. We have selected the Platerskill clove for this purpose, although it is in no respect superior to several landscapes of the same region (Pl. xix. and Fig. 7). The panoramic view is taken from the ridge east of Catskill, on the opposite side of the river. The general appearance of stratification is intended to be exhibited. It was more particularly designed to illustrate the denudation of the mountain, and the deep cuts which were made in the drift era: it is an accurate representation of the north face or slope. The first view, the Platerskill clove, looks down upon the valley of the Hudson, over the fine flourishing village of Saugerties. The river appears in clear weather like a silver band winding through a high plane, beyond which the taconic hills seem to rise in even slopes, till far in the horizon the whole country becomes dim and lost in air. The view from the Catskill Mountain House is still more extensive, as it is not shut in on either side by towering peaks. It is here the world becomes a world; it is here man becomes a man, and physical nature speaks a lesson full of rich and precious truths.

The sectional illustrations of the relations of the rocks described in the foregoing pages, may be found on Pl. xxi., sections 3 and 5.

VI. THE UPPER ROCKS OF NEW-YORK EQUIVALENT TO THE DEVONIAN SYSTEM OF ENGLAND AND THE CONTINENT.

Mr. Conrad was the first American geologist who perceived the equivalency of the upper New-York rocks, to those which were described by Mr. Phillips under the name of *Devonian.* To him also is to be given the credit of identifying the Silurian system with the lower rocks of this State. When the outlines of resemblance have been traced, it requires only diligence and moderate capacity to fill up the details. While it is admitted, however, that the New-York and Silurian rocks have been proved by American geologists to belong to a coeval period, it is not proved that the two are identical. Such a closeness of agreement, in such distant rocks, could not be expected. This much seems to be established, namely, that the rocks of the two continents, limited upwards by the Coal series, and by the Taconic system below, were deposited during the same period; but whatever of a modifying nature existed in either continent, had its influence on each series respectively. A prolongation of a particular deposit beyond the corresponding one of a distant continent, often took place. Intercalated members appear in a few instances. Organic beings were formed on the same types, but rarely identical. While resemblances were preserved in the greater number, the novelties were rarely common. As New-Holland must have her kangaroos, and quadruped-like forms in her aviaries; the Galapagos, their lizard forms; and Africa and America, each their peculiar faunas; so analogy forbids our expectancy that the faunas of our two silurian worlds should be identical. It is not a variety, however, which arises from necessity, from obedience to physical causes: the variety exists for variety's sake, and to fill creation with diversified grades of being.

The advancement of geology in this country received a new impulse, when its cultivators began to study our rocks independently of European formations. So long as investigations were directed towards identification with foreign rocks, just so long our own formations remained unknown to us, perhaps from the want of proper characters by which they could be made out. The study of fossils has, in later years, been followed by a real progress in the science of geology; and this has arisen, not so much from the use of fossils as characteristics, as from an independence which they gave to the thoughts and methods of observers. They gave us the power to compare our rocks with each other at distant points, and to work out our system on a basis which is truly American, and which has really created an American geology. This result has been practically of great value here, in addition to the confirmation of leading principles which had preceded it abroad. We have now our Silurian and Devonian systems sufficiently well defined to answer all the ends of science. The work of accurately identifying strata may go on, now that correct outlines have been marked out, and our great landmarks are so well defined.

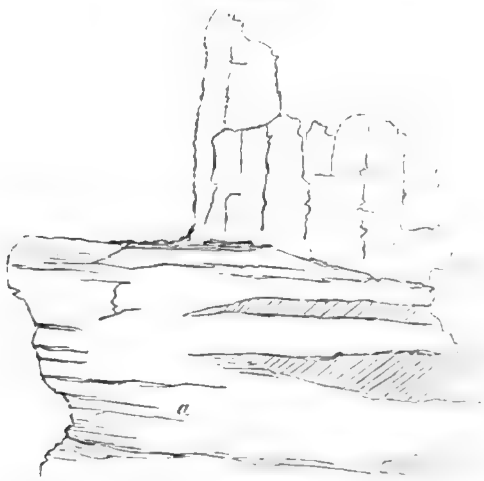
Summary of facts respecting the upper rocks of the New-York, Silurian, and Devonian systems.

1. The series of rocks above the Tully limestone consists of alternating masses of sandstone, slate and shale. The greatest mass of slate is the Genesee slate; and the greatest mass of sandstone, in continuous beds, is the Portage group.
2. The rocks, from the Genesee slate to the conglomerates of the Coal, form one series; and though this series is divided into groups, the subordinate divisions are made for convenience rather than utility or necessity: they serve, however, one or two purposes, namely, those parts of the series which have intercalated members, or other differences, are more fully brought to view, the economical portions may be clearly defined, and the comparison of two distant points is made more striking. It will be said that the groups are important, and an appeal may be made to the fossils for sustaining the position. The better division of the series seems to be into upper and lower, or upper, middle and lower. The division of the rocks above the Taconic, and below the Coal, into two great systems, the Silurian and Devonian, simplifies the study of the geology, and encumbers the mind of the student less than that which makes many subordinate parts. The deepest part of the Devonian sea appears to have been in the region of the Catskill series; and if we may form an opinion of the continuous depth of such a sea, from the extension and thickness of a formation, it would seem that the depth increased rapidly upon the eastern shore, but shallowed more slowly to the southwest. This view seems to be sustained by the fact that the prolongation of the Silurian and Devonian systems eastward is quite limited, some of the beds of the Lower Silurian extending only five or six miles east of the city of Hudson; while in order to place ourselves in the midst of a deep silurian and devonian sea, we have only to travel ten miles southwesterly from this city. The whole mass composing both systems disappears at once, as it were, on the eastern side, thinning out suddenly; and the Taconic slates, plunging down at a steep angle, form a basis upon which the whole is supported.
3. There is less difference between the lower part of the Devonian and upper Silurian in New-York, than there is between the Champlain and the Ontario divisions.
4. The economical products are fine and valuable flags, quarries of which may be opened through a wide horizontal as well as vertical range. The rock contains neither ores, limestones, nor brine springs.
5. Some of the springs, which issue from the Genesee slate, are hydrosulphuretted in an eminent degree; while the springs of the rocks above the slate, are pure as those of a primary district.
6. The country underlaid by these rocks is hilly, and the slopes afford an excellent soil for grazing. Wheat, though not the natural crop, is still raised on the bottoms of the narrow valleys.

VII. NEW RED SANDSTONE.

It is a singular fact, that this rock, whose position is above the Carboniferous series, should range along in close proximity to Upper Silurian rocks, almost touch the Old Red sandstone, and yet never be found reposing upon either. It occupies a small area only in New-York. It borders the west of the Hudson river for twenty miles, underlying all that remarkable and highly picturesque shore known as the Palisadoes. The sandstone supports the pillars, the material of which seems to have been ejected through the rents in the sandstone beds. That this may have taken place is not at all improbable, inasmuch as the material of which the columns of greenstone are composed is interlaminated with the layers of sandstone in such a way that it can scarcely be questioned but that it was forced between them after consolidation, and while the greenstone was in a molten state. This statement is corroborated by the appearance of the sandstone. It is not only partially melted, but the iron, which formed a constituent part of it, is segregated into masses and thin veins in a crystalline state. Fig. 32 is an illustration of the relative position of the rocks near Slaughter's landing.

Fig. 32.



a. Horizontal beds of sandstone : the sandstone, when in contact with the greenstone above, is often white or gray, compact and hard, portions of which resemble hornstone or chert.

b. Columnar greenstone, resting upon the sandstone.

c. Injected beds of the same, and communicating with the columnar mass above.

The New Red sandstone is undistinguishable lithologically from the Old Red or even the Medina sandstone : it is at base a conglomerate. The Potomac marble, as it is called, forms the base of this rock. This rare conglomerate rests on the Magnesian slate and Sparry limestone of the Taconic system, near Stony point, below Caldwell. The other parts of the rock are a coarse micaceous sandstone; and a thin-bedded red and black shale, passing into a soft marl, more or less variegated and spotted with green.

The New Red sandstone is a highly interesting formation. It is rendered so by certain marks or impressions upon the strata, so closely resembling footmarks, that few now doubt the truth of this hypothesis of their origin. The evidence, however, of the truth of this hypothesis, does not rest upon the shape of the impressions alone: these are so exact and uniform, that if there were no other ground for this belief, it would be difficult to maintain that they had any other origin than that now ascribed to them. In addition to this evidence, is that which is drawn from their position with respect to each other; for example, where a series of footmarks are in a line, the toes turn alternately to the right and left, precisely like the tracks made by birds when walking upon mud or sand. There is a uniformity, too, in regard to the number of toes; being usually three before, and sometimes the impression of the hind claw. There are also the swellings between the joints of the toes; so that in all those points in which they may be compared with the footprints of animals, it is found that the agreement is so exact, that we are forced to admit that the marks in question were made by shore birds travelling upon the beach, while the rock was being deposited. Numerous species of birds existed at this period, inasmuch as the tracks are of various sizes, beginning with the tracks of our small sandpiper, and ending with those twice as large as the tracks of the ostrich.

Footmarks have been found by Mr. Redfield in New-Jersey, not many miles from the New-York State line. President Hitchcock and Dr. Dean of Greenfield (Mass.), have been the most successful cultivators of this branch of palæontology.

Other marks are often found upon the smooth red shale, of a rounded shape, which are usually called *fossil rain-drops*. These marks, however, are questionable in their origin, inasmuch as bubbles issuing from a muddy bottom often produce like appearances in the mud after it has become indurated by exposure to the sun and air; still there is no great objection to the conjecture that they were made by the pattering of drops of water upon a soft surface. We can see no objection to the notion that it might have rained in the era of this sandstone, as well as on the 4th of July, 1846.

This rock is distinguished from others, by peculiar fossil fishes. They belong to the dark shaly part; and what makes the palæontology of the rock interesting, is the absence of mollusca and conchifera. The fish are solitary, and seem to have been the sole possessors of the Red Sandstone sea.

VIII. TERTIARY SYSTEM.

§ 1. Tertiary and post-tertiary clays; Albany and Lake Champlain clays.

This formation is the most recent in New-York, if we except the peat and marl beds, which have usually been referred to the present era. It apparently consists of three portions: the lowest, a blue stiff clay; the middle, a lighter colored clay; and the uppermost, a sand. The middle portion differs but little from the lower in composition. The difference in color is partly owing to a longer exposure to the atmosphere, by which it becomes lighter, and even a pale brown or drab. The sand appears between the layers, but only in extremely thin beds: the great mass of sand is on the top of the formation; it is a marine deposit, a point which was determined at an early period of the New-York survey, by the discovery of fossils, known as living inhabitants of the Atlantic ocean.

The largest or most extensive deposit occupies the Champlain and the St. Lawrence basins, from which it extends into the Hudson valley. It is impossible to determine its real extent; for it differs in no respect from other clays, and can not be distinguished from them, unless it is traced continuously to beds which are well known, or to those which contain fossils. It is one hundred feet thick upon Lake Champlain; and what is worthy of special notice, is that the deposit rests on the grooved surfaces of the Champlain rocks, or else upon beds of drift. It exhibits all the characters of a deposit made during a period of perfect quietude. We have to notice, however, that at the close of this period, one of some violence succeeded; this is clearly indicated by the removal of large portions of the formation. The sand, and part of the clay, has apparently been removed to distant points, leaving only the lower portion, and even sometimes the whole mass down to the rock has been removed.

§ 2. Fossils of the tertiary system.

About twenty-two or twenty-five species of marine animals have been discovered towards the upper part of the clay. The indurated clay, or claystones, in one or two instances, have contained fossil fish. Besides these, a fossil jaw of a walrus was found by Mr. Lyell in this formation in Maine.

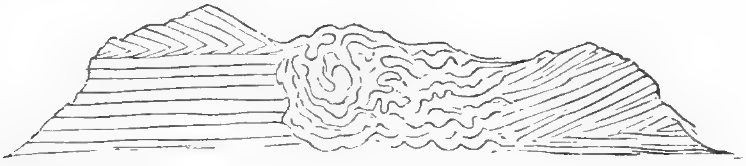
Of the conchifera belonging to this deposit, the *Saxicava rugosa*, and the *Sanguinolaria*, have a wide distribution; the remaining species are quite limited, and are confined to one or two places on the borders of Lake Champlain and of the River St. Lawrence. At Beauport, a village four miles from the city of Quebec, about fifteen species of fossils have been found, all of them distributed throughout a single bank of clay and sand. Some of the same species inhabit the northern seas; and hence Mr. Lyell maintains, that during the era of this deposit, the temperature of the part of the continent where these fossils are now found was lower than it is at present. Doubts are thrown over the justness of this conclusion, by the fact that some of the species are the present inhabitants of the Atlantic ocean on the coast of Maine; that marine animals have a wide distribution; and as our waters have not been examined very carefully, it is not at all improbable but that all may yet be found in the range of latitude which these fossils themselves now occupy. We have reason to expect this.

Upon Lake Champlain, Port Kent is the best point for procuring these fossils. The locality is about eighty rods south of the steamboat landing, in the clay bank, twenty-five feet above the level of the lake. If the shells are immersed in a weak solution of glue, the colors will revive and become permanent.

For additional facts respecting this formation, see the Report of the Second district, in which the fossils are figured.

The Tertiary system, as already stated, extends into the valley of the Hudson. The fact of its extension is sustained by its continuity with that in the valley or basin of the Champlain. The character of the formation, in its southern prolongation, does not differ essentially from that already given. It may be regarded as extending to New-York bay, and probably westward into the valley of the Mohawk. Its full extent, however, can not be clearly defined. Its composition is quite uniform, as will appear by the analysis of the clay obtained at distant points. At Albany, this clay is an important material for making brick. In the process of extending the bounds of the city, a mass from ten to twenty feet thick has been removed, in order to bring the surface to a uniform grade. The banks exposed by this operation often present many curious contortions, of an anomalous character, and difficult to explain. A mass of ten feet thickness which has been exposed by a vertical section, is highly contorted, while its base rests upon horizontal strata. An illustration of this curious contortion is furnished in the following cut (fig. 33). A portion

Fig. 33.



on the left, which is bent, rests on the undisturbed clay bed below : in the middle it is still more contorted, and is a miniature representation of phenomena which are often witnessed in slates and shales of the different formations, and usually explained by the action of some uplifting force, accompanied by lateral pressure. This explanation is properly given in many instances. These contortions of the clay beds, however, seem to indicate the possibility of their production by other causes; for there will be found but few persons, who, after examining the instances here specified, will advocate the doctrine that these clay beds have been forced upward or wrinkled by lateral pressure, in the mode this force is usually supposed to act. It appears, after a careful examination of the circumstaces attending these irregularities, that they take place at points where the adjacent beds have been removed: they are then left unsupported on one side; and in consequence of this state of the beds, they are liable to slide down in mass. This movement may extend for some considerable distance, and sometimes the sand has flowed into and filled the excavations. There are, also, occasional faults in the clay and sand beds; and, as in other cases of a like nature among rocks, these faults give origin to springs.

In the excavations in the city of Albany, a boulder is sometimes found in the clay, but always near the top of the formation. This assertion is intended to be confined to the true sedimentary beds: it does not apply to the drift beds, which are sometimes exposed in this valley. They repose generally upon the rock, and belong to the base of the formation, or to that moderate drift period which followed the deposition of the clay and sand beds whose strata are uniform and unbroken, and which are comparatively free from coarse sand, gravel and boulders.

The sand of this formation is yellowish, porous, and rather barren. There are beds, however, which are quite the reverse of this, and are really remarkable; they form the excellent moulding sand so well known in the vicinity of Albany. It is a sand which is evenly mixed with loam, and which retains a certain amount of moisture under all circumstances. Even when exposed in heaps in dry weather, it appears moist beneath the surface, and when pressed in the hand, retains the shape and form given it. This sand, too, forms an excellent soil, of which we shall have occasion to speak hereafter.

§ 3. Marl and peat.

Before dismissing those formations which have been called *tertiary* and *post-tertiary*, it is proper to speak of the deposits which are considered by all geologists as the most recent, and which really are the proximate formations that connect the modern deposits with the ancient; the present, with the past; and in which geological changes bear an aspect more real than those of the Carboniferous or Silurian era. It is by means of the fossils of a period just anterior to the present, and which is not to be regarded precisely as a tangent to it, but rather as forming with it a continuous portion of a great circle, that we may familiarize our minds with the nature of those peculiar changes and phenomena which clothe the history of the earth with so much interest. Just before us, there lived races of animals, whose forms and whose habits scarcely differed from those which are now familiar to us: they were really members of different families at present existing and known to us, having affinities and relationships with them of the closest kind. Knowing the living and the present, we also know the dead and the past. Conjoined in both periods, we have the last term of a series, from which we may travel back to the remoter periods, and trace up the analogies as they have been successively developed. We judge the past by the present; and from the store of knowledge accumulated by modern discovery and modern induction, we are enabled to supply many of the links which are wanting to complete the system of a perfect scale of being, such as shall represent the whole of life and organization as it was made for the earth. The chain is complete, and its extremities are united in one eternally revolving circle of life. It looks an ocean of being, formed by the contribution of vast numbers of streams of all grades of magnitude, meandering and inosculating in a thousand arbitrary ways, but all finally merging in the great deep of unfathomable existence.

The marl and peat beds rest upon a diluvial stratum, that seems to have been formed immediately after the Champlain tertiary; and, at first view, they seem to be but insignificant formations. They are not, however, so very insignificant, if the presence of fossils can impart importance to a formation; for in these beds, the remains of extinct elephants, mastodons or mammoths, and the gigantic beaver and deer, are deposited. Though these formations are never very extensive, or spread widely over a country continuously, yet they are numerous: they make up in number, what they lack in breadth. They occupy shallow basin-form depressions, which were once submerged by small bodies of fresh water. The marl formation itself is a white calcareous earth, which is never consolidated. There is no regularity in the depth of this earth: it varies from one or two feet, to sixty. Peat, a peculiar vegetable product, usually overlies it, though it is not always present: the order is never reversed; the marl never rests on the peat, but the latter often exists independently of the former.

It is scarcely necessary that we should attempt to describe the localities where these materials exist. It is sufficient to remark, in this place, that they are numerous in all the counties bordering the Hudson river, and the Erie and Champlain canals. Peat beds occur by themselves in most of the highland marshes, and marl occasionally in high primary districts at a distance from calcareous rocks.

The fossils of these formations have been alluded to, and it is only recently that they have assumed the interest to which they are entitled. Formerly there were too few of them known to attract much attention, and their position was not sufficiently well determined to enable geologists to found upon their existence an opinion as it regards the period of their extinction. The obscurity in which this question was shrouded, has been partially removed by the determination of the relative position of the beds in which the fossils have been found. The beds are situated uniformly in the following order: 1. Diluvial gravel and boulders; 2. Fine sediment of blue clay; 3. Marl; 4. Peat. The two inferior beds are below the fossils; and the marl, which is the thinnest deposit, is the principal repository of the remains of quadrupeds. The following animals have been found in this formation: The elephant; the mastodon or mammoth; two species of deer; an animal closely allied to the beaver, first discovered in Ohio, but since found in the Cayuga marshes in this State; the ox; the horse; and the sheep, or an animal belonging the family. All the species found in this deposit are extinct; although the freshwater mollusca, which abound in them, are still living in all our freshwater bays.

From the preceding facts, it is obvious that these animals have become extinct since the drift period, an inference which is warranted from the uniform position of the marl and peat beds. This inference is sustained by the state of the bones, which still contain gelatine or other organic matter: they are not *fossilized*, as all the older remains usually are.

The cause which operated so extensively, and which resulted in the total extinction of these vigorous races, is only to be conjectured. We have no data on which to found a rational hypothesis concerning it. Whatever it may have been, it was one affecting the same races over an immensely extended territory; one which operated over the whole of the northern part of this continent, as well as in that of Europe.

CHAPTER VII.

ORIGIN, DISTRIBUTION, AND CLASSIFICATION OF THE SOILS OF NEW-YORK.

I. ORIGIN OF SOILS. II. DISTRIBUTION OF SOILS : DILUVIAL ACTION ; TRANSPORTATION OF BOULDERS ; SCORING OF ROCKS : CAUSES OF DILUVIAL ACTION : ERA OF DILUVIAL ACTION : FINAL CAUSE OF DILUVIAL ACTION. III. CLASSIFICATION OF SOILS ; ELEMENTS OF SOILS ; TEMPERATURE OF SOILS ; RELATIONS OF SOILS TO THE ROCKS ON WHICH THEY REPOSE ; ANALYSIS OF SOILS. REMARKS ON CLIMATE.

In the two preceding chapters, we have given a description of the rocks of the State, and determined their range and location ; and we now proceed to investigate the origin of the soil, and the manner of its distribution.

I. ORIGIN OF SOILS.

In describing the rocks of New-York, we have had occasion to refer to the mode in which sedimentary rocks are formed ; the first step in the process being a destructive one upon the solid strata, by which the exposed surfaces are abraded. Several causes combine to produce this result, each of which varies in intensity according to certain circumstances. One of the ordinary effects of water is to dissolve the materials composing a rock, the dissolution being promoted by the presence of carbonic acid held in solution by the water. All rocks containing carbonate of lime, are dissolved more or less by water charged with this acid. The materials thus dissolved, and held in chemical solution, are not deposited at once. If the water is saturated, or nearly so, the carbonate of lime will separate by crystallization, especially if the fluid be diminished afterwards by evaporation ; and it appears that water, highly charged with carbonic acid, may dissolve a large quantity of solid matter, as carbonate of lime, magnesia or iron, or other bases. In these instances, all that is required, in order that a deposit should be made, is that a portion of the carbonic acid be set free ; and this takes place when the solution is exposed to the atmosphere. Deposits around springs are formed in this manner : in these cases, however, the matter separated is usually hard and crystalline. In the same manner, deposits, not inconsiderable in extent, may be formed in the ocean.

But this mode of waste of the existing solid rocks is not the one by which soils are made: these originate almost exclusively from mechanical action by abrasion, and from atmospheric influences, by which particles are separated from the rock and from each other. This atmospheric action, however, is promoted by certain chemical changes among the elements of the rock. Iron, in a state of protoxide, absorbs another equivalent of oxygen from the atmosphere, and is converted into the peroxide, and such a change would be one step towards disintegration. So almost any change whatever in the constitution of the elements of a rock, though it is only a mechanical product, will be followed by a separation of its parts. All changes affecting the composition of a rock are promoted or aided by frost. Water is absorbed more or less by rocks during the frosts of winter, and the superficial portions gradually crumble and become detached. The exposed surface is thus greatly increased, and hence the chemical changes are proportionally promoted.

The nature of the rock itself may or may not favor disintegration. Rocks whose elements contain an alkali, or alkaline earth, undergo changes by which they are directly converted into soils. Some granites and greenstones are of this description. Aluminous rocks, soft slates and shales, are eminently disposed to disintegration: they break down by moisture, without freezing. The presence of sulphuret of iron in these, or in any other rocks, promotes those changes by which they become soils, especially when the iron is in the state of a protosulphuret. Other rocks, the pure sandstones and limestones, are acted upon more slowly.

Another condition which promotes the formation of soils, is the alternation of hard and soft layers; the latter are destroyed, leaving those which rest upon them to fall by their own weight.

Rocks exposed on the tops of mountains decay rapidly: the intensity of the frost, and the length of time during which they are exposed to it; the suddenness of the changes of temperature to which they are subjected; and the dampness of the air during the summer, when watery vapours condense upon their summits and sides, are circumstances that favor the destruction of rocks in these places.

With these causes in continual operation, the solid strata are broken down into soil. No matter how hard the rock may be: some change takes place; some impression is made upon it, and some matter is separated from it, which goes to increase the amount of debris covering the surface of the earth.

If these, however, were the only causes in operation; if there were no other movements than those of the simple separation of the particles of rock from each other, the soil would be very different from what we now find it: it would be less in quantity, or thinner, over the whole earth, and its general characters would be somewhat different. Each rock would then be covered by its own debris, and the soil would partake exclusively of the character of the rock from which it is derived. But soil or debris, when formed, is not suffered to remain *in situ;* and this leads us to the consideration of those causes by which it is and has been distributed.

II. DISTRIBUTION OF SOILS.

The common agent, which is now general, and is quite effective in the distribution of soils, is water. We might consider, were it necessary, the many ways by which water transports soil from place to place, and the times when its action is the most powerful; but it seems unnecessary to dwell upon the latter question. We need only to recognize this particular power of water, for the purpose of familiarizing us with the fact that all running water bears along sediment, and leaves it when the force of the current diminishes: the coarsest portion is deposited early; the finer is carried forwards farther, and the extremely comminuted material may be moved as long as the current moves at all. When it has reached the point of destination, and ceases to move forward, all the suspended material falls to the bottom, and there forms a fine layer of sand or mud. Transportation from the higher grounds to the lower, takes place during every rain or shower, and meadow land is partially formed in this way. The higher grounds are continually losing, and the lower are gaining: the former become thinner, and the latter thicker.

We recognize a power, then, in water, to transport and carry along materials which have been already separated from their parent rock: this is only an ordinary movement, an almost daily operation. But we can not, if we are acquainted with all the facts bearing upon this subject, regard these daily operations as the only ones by which the soil has been distributed in the manner we find it over the face of the earth. There are evidences clear and indisputable of a general movement of the soil, together with all the loose rocks, aside from and in addition to the ordinary movements to which it has been subjected, which can not be explained by any cause or causes now in operation. Such a movement as is here alluded to has been recognized over a great part of the earth, but more especially in the northern hemisphere; and from its strongly marked features, from the indelible evidences which this movement has left in its own characteristic phenomena, all geologists now agree in stating alike the main facts by which it is known and distinguished. The movement here referred to has usually been described under the name of *diluvial action*, on the hypothesis that it took place at the time of the deluge.

This subject may be treated under the following heads:

1. The phenomena of diluvial action.
2. The mode in which the soil of New-York was distributed by diluvial action.
3. The causes of diluvial action.

§ 1. Phenomena of diluvial action.

Although the descriptive name, *diluvial action*, is retained, we do not wish to be understood to say that the Noachian deluge had any thing to do with it: it may, or it may not, have taken place at that time. We only mean to be understood, by employing these words, that it was by a catastrophe, allied in character and kind to that which overwhelmed the earth in the days of Noah. The record of such a catastrophe is contained in two remarkable phenomena: first, the presence of immense rocks, generally called *boulders*, in places where they could not have been put by any human means; and secondly, by the occurrence of marks or scorings upon the surfaces of rocks, which could not be made by causes such as are now in operation.

Transportation of boulders. The occurrence of rocks in the soil or upon it, or upon other naked rocks, of a kind different from any in the immediate vicinity, is a phenomenon that arrested the attention of the earliest observers. For example, detached masses of granite and gneiss were found resting upon limestone or slate, or upon recent sedimentary rocks; or, on the contrary, detached sedimentary rocks were found reposing upon granite or gneiss, the general phenomenon consisting in the presence of a loose rock at a distance from its known parent bed. The importance and interest of this phenomenon is increased, when we take into consideration the great distance which the fragment has sometimes travelled, a distance which is often susceptible of determination by direct proof. Where the boulder consists of a particular kind of granite, or of a peculiar variety of rock, it may often be referred to a distant locality of rocks identical with it in constitution. In proof of this assertion, we may state that hypersthene rock has been found in fragments on the Catskill range, and in Orange county and elsewhere; but this peculiar rock is known to exist *in situ* nowhere in this State, except in Essex county, where it forms the nucleus of the Adirondack mountains. In this case, then, the inference is, that by some means or other, the boulders of hypersthene rock, found in Orange county, were brought from Essex; and what strengthens this inference, is the fact that they are strewed along in this direction to the very mountains themselves, that is, they may be traced to their beds. This single fact is illustrative of this part of the subject, namely, that all boulders or loose stones, occurring far away from their parent beds, have suffered transportation.

We may extend this subject farther. If the soil is sufficiently examined, it will often be found composed of materials different from any in the vicinity. Thus, mica in glimmering scales is seen among the soil of an argillaceous slate, or of a limestone district: hence the inference that the soil has been brought from a distance; and as the soil and the boulders are mixed together, we can scarcely avoid the conclusion that they have been transported together, perhaps in mass and from one district. All these facts, however, may be kept apart from hypothesis, and it may be that in the facts alone is comprised all that need be said upon the subject.

There is another circumstance which it is here necessary to inquire into, namely, the direction in which the soil and boulders have been carried. On this point, we refer to what has just been said concerning the boulders of hypersthene found in Orange county: these are located nearly south from the mountains of Essex county, where they originated; and we may say, for once, that this instance represents, in general, the direction in which all the boulders and soil of the northern hemisphere have been transferred. We must, it is true, admit of some variation in the direction of these movements; but it is remarkable that this variation is confined between the limits of a southeast and a southwest course, with a few interesting exceptions which will be given in the sequel. The number of recorded observations which go to establish the general fact of a southerly distribution of the soil and boulders, is extremely great, and is gathered from the whole extent of country between the Atlantic ocean and the base of the Rocky mountains; and no instance has happened in which a boulder has travelled northwardly, or been found in a situation with its parent rock towards the south. The two great facts, then, which geologists have been able to establish on this question as general, are, first, the transportation of rocks and soils; and, secondly, the southerly direction in which they have been uniformly carried. According to this general announcement, a soil occupying any given situation, if out of place, lies south of the rock which gave it origin; and the pebbles which are large enough to be readily distinguished, indicate the origin of the soil, or the rock to which it belongs. If we find many limestone pebbles, or if lumps of earth are found to effervesce with vinegar or other acids, it shows that the soil is formed of the debris of a calcareous rock.

A soil which contains many pebbles, or rolled stones like paving stones, is frequently called *drift*, a term which is convenient, as well as short. All soils which have been transported, may be termed *drift;* but where cobblestones make up a large proportion of a formation, the evidence of its having been *drifted* is obvious, and hence the term is usually confined to beds exhibiting these sure marks of transportation. The term *drift*, however, would not be properly applied to a pebbly beach.

Scored surfaces. The second phenomenon above mentioned, which is believed to be somehow connected with the transportation of soils, is an effect observed upon hard surfaces over which the drifting soil has passed. The upper surface of most hard rocks, of whatever age they may be, is scratched, grooved, or sometimes polished. These effects differ at different places, according to the nature of the materials which have passed over the surface. If these materials were coarse and heavy, deep scorings seem to have been the only result; if of a finer texture, the surface is slightly scratched, or it may be polished, an effect which can not be produced by coarse substances. The markings vary in degree, from the slightest scratch, to a groove four or five inches in depth. The direction of these scratches or grooves is southerly; and it is a curious fact that they are not made in varying directions, and without order, but always correspond to the direction which, from other considerations, we find the soil to have taken in its transportation: in other words, the grooves run in a southerly direction, and are parallel in sets; and, as a general rule, their directions are confined within the limits of the southeast and southwest points of the compass. From this correspondence between the direction of the grooves, and that of the transportation of the boulders and soil, we are legitimately authorised to associate the two phenomena as cotemporaneous effects of one common cause, whatever that cause may have been. This interpretation seems to be borne out by the fact, that in uncovering a rock of its soil, which we usually denominate *drift*, the bottom boulders are frequently found each occupying the groove it had made, like a plough left in its furrow; and like as the furrow extends no further than the point at which the plough was arrested in its motion, so the groove formed by the moving rock stops with the rock itself. From these and kindred facts, we infer the general transportation of the soil, or at least of that portion of it which is called drift, and which in some parts of the country forms three-fourths of its entire contents.

In order to put the reader in possession of all that relates to this subject, we must dwell a little longer upon it, and state some exceptions to the statements above given. The direction we have assigned as that of the general movement of the boulders and drift, is that which is indicated by extended observations; but some instances of deviation have been observed, in which the drift has been spread over a wider area, and surpassed the limits we have given as those of its direction. In some cases, drift has been forced from its wonted direction by obstacles to its progress; and in others, it has evidently followed the course of pre-existing vallies. As examples of both cases, we may state that the direction of the grooves upon the slate of the Hudson and Champlain vallies is conformable to the direction of these vallies; and where the direction of the grooves of a number of vallies is compared with that of the vallies themselves, there is quite a coincidence. The most remarkable exception we have observed to the general direction of the grooves above stated, occurs in the Catskill mountains. As we approach these mountains from the north, we find the grooves directed towards the base of the mountains; but on reaching the base, on the side toward the Hudson river, the grooves are deflected decidedly to the east, and this deflection is the greatest in the gorges and mountain vallies. On the several routes which wind around the spurs, the grooves point directly east and west by the compass, in all cases where the vallies themselves run east and west, thus forming a right angle with the direction of the grooves at the northern base of the range; a change of direction evidently produced by the obstacles met by the moving current, and which deflected it to the eastward. These exceptional cases, however, are local, and very few in comparison to those in which the grooves maintain the general direction from north to south; nevertheless they are invested with much interest, and seem to point out that the general shape and contour of the surface, at the time our soils were undergoing transportation, were much the same as they are now, although that surface itself was essentially modified by the operation which accumulated upon it these loose materials from a distance.

§ 2. Distribution of soils by diluvial action.

We come now to the consideration of the local distribution of soils, and more especially the particular manner in which the soil of New-York has been distributed. Boulders, in the first place, are usually distributed in belts upon the hills or elevated grounds, and vallies are comparatively free from those which have travelled a great distance. Boulders are rarely found in vallies, flat lands, or meadows; but they are so much the more numerous upon hillsides, that some special condition must have favored their tendency to lodge in these situations. We merely advert to this general fact in this place, however, and proceed to inquire into their geographical distribution.

Beginning on the eastern borders of the State, and proceeding westward, we may arrange the soil and boulders in separate and distinct belts. The first belt, according to this view, comprises the soil and boulders resting upon the Taconic system of rocks, which borders the State eastwardly. Here almost all of the boulders, and the whole of the soil, consist of the debris of the Taconic rocks. Now it has been found that this system of rocks ranges far north, and in the direction which the drift has travelled : hence the soil is what it would be had it never been moved at all ; it is the soil of the rock upon which it reposes. This forms the first belt, and extends to the slope of the valley of the Hudson river. In the valley, however, we begin to find the rocks and soil of the lower part of the New-York system, together with a few granitic, gneissoid, and hornblendic boulders ; but these constitute only a small proportion of the matters composing the soil of the valley. From the eastern rise of the Hudson valley, to a point a few miles west of the city of Schenectady, the boulders and soil are derived from the Champlain group : this constitutes the second belt. At and near the village of Amsterdam, and extending perhaps as far west as Canajoharie, hypersthene boulders are quite numerous, and serve to characterize a belt, which, so far as boulders are concerned, is somewhat peculiar, by the presence of a great number from the Adirondack mountains : it is therefore considered as a distinct belt, although the soil is still that derived from the Hudson-river or Champlain rocks. This is the belt of boulders that extends south into Orange county, and perhaps much farther in the same direction.

West of Littlefalls, the Potsdam and Medina sandstone, together with the Calciferous sandrock, and also the Primary rocks of the western slope of the high grounds of Jefferson and St. Lawrence counties, abound ; but in Herkimer county, or the eastern part of Oneida, we believe the hypersthene boulders are not found, or at least are not so numerous. When we reach that belt, however, which ranges along the St. Lawrence river, hypersthene boulders are again common. But here there seems to be a range or belt of them entirely distinct from those of the Adirondack mountains, which are found in the belt at or near Amsterdam. The former can not be traced to these mountains, but range onwards farther to the north, and probably extend to Labrador, or the great primary region of Canada West. This hypersthene belt is much wider than the first, and even reaches the borders of Lake Erie.

On the line of the Erie canal, it is impossible to distinguish belts of boulders, for as soon as we pass the Little falls and Herkimer county, the sedimenary rocks begin to trend to the west, and from hence the boulders of Medina sandstone extend to Lake Erie. There can be distinguished, then, only two belts between the village of Littlefalls and Lake Erie. Still some of the rocks form distinct bands of drift : the Niagara limestone, for example, at Rochester, has been carried a few miles south from that city, where its fragments lie in great numbers, and in their original angular condition, without the least change having been wrought upon their sharp corners. This is sometimes the case with other boulders also, but they are usually more or less rounded.

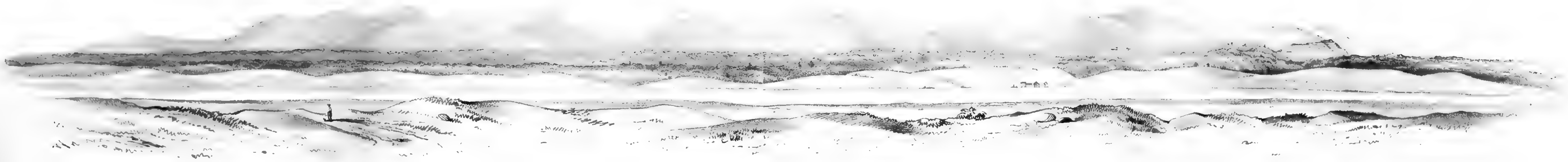
In the middle and western counties of New-York, where the outcrop of the rocks is north, and where the line of strike is nearly east and west, the soil of each rock is carried south upon the next one above, or perhaps beyond it. Here then the character of the soil of a belt running east and west, is modified by intermixture with that derived from a rock at a distance. For illustration, we may cite the soil of the Medina sandstone, which, cropping out on the south shore of Lake Ontario, its debris is found overlying the next group of rocks south of it; and a similar change has taken place with the soil of the Onondaga-salt group, which is carried up to the Onondaga limestone, and even still farther south, and it thus modifies the soil embraced in a belt twenty-five or thirty miles south. To this fact, the lands south are greatly indebted for their excellent properties in bearing wheat; but we shall have occasion to speak more particularly of this hereafter.

If the strike of the rocks of Western New-York was parallel to the Taconic range, the distribution of the soil would have altered materially the character of the belt of country at the base of the Allegany ridge. Notwithstanding the transport of the soil, it is not difficult to find large areas with soil composed of the debris of the rocks beneath: it results from the rapid decomposition of the rocks, or the ease with which air and water convert them into pulverulent matter. This too has favored the production of a great depth of soil; and hence we find in Livingston county, and in the tier of counties in the same east and west range, an immense depth of soil. In the Taconic range, although slates form a large proportion of the strata, yet in consequence of the strike, and the angle at which they are inclined to the horizon, far less debris has been formed than in Central New-York. The strike is nearly in the direction of the drift current; and hence the effect was far less than it would have been if the loose materials had been driven directly against the outcropping edges of the inferior rocks, as in the case just noticed. This is strikingly manifested in some parts of the Helderberg range, where the current encountered the outcropping edges of the thin-bedded sandstone of the upper Silurian beds, and not only broke them up, but transported immense quantities far towards the base of the Catskill mountains, where it lies in such profusion as to cover extensive areas with broken rocks, and thus to render large tracts of land nearly worthless. One of the rocks that is very abundantly strewed over the fields of Greene county, is the Oriskany sandstone, which, in consequence of its hardness, was able to resist attrition. The drifted soil of this region is frequently one or two hundred feet deep, and it appears in many places to have been derived from the outcropping edges of the rocks of Albany county.

§ 3. Causes of diluvial action.

We now proceed to inquire into the causes or agencies concerned in the breaking up of rocks, and in the transportation of the debris which covered them at the time these agencies or powers were called into operation. We embrace these two phenomena in the single question concerning the transportation of soils; and in framing a hypothesis adequate to the solution of this question, it is essential that every assumption should bear with equal

PLATE VII



force upon each of the two phenomena, so that whatever explains the one, shall also explain the other.

In some places, boulders, the most effective instruments for scoring rocks, lie in immediate contact with the scored surfaces, and in so unequivocal a relation to the grooves and surfaces themselves, that we deem it a rational judgment that they were the immediate agents of the work. This view excludes the hypothesis which maintains the groovings to have been produced, in all cases, by the movement of icebergs shod with boulders and gravel; for if the great mass of the soil has been moved as we have reason to believe, then icebergs are incompetent to the work: they can not have pushed forward the whole coating of the northern hemisphere. That they do carry boulders and gravel, is true, and they have assisted in the distribution of these materials over various portions of the surface of the earth; but their agency in this operation becomes very insignificant, when compared with what has actually been done: we might as well attribute the work to our mountain rills.

Our view also excludes the hypothesis which ascribes the scoring of our rocks to the operation of glaciers. A general movement and transport of the entire body of the soil, is a condition of the surface totally at variance with the existence and motion of glaciers. The glacier hypothesis necessarily supposes a state of things entirely different from that which evidently existed during the drift period. It supposes a high region, or one of perpetual frost, surrounded by a mild and temperate one, toward which the melting glacier slides, bearing along its burthen of rocks and stones and gravel. Such a hypothesis implies the existence of an elevated region from which the striæ would diverge, or an elevated centre towards which they would point; but the facts themselves furnish no indications of such an arrangement. The striæ or grooves point southward; and though in some mountain passes they are deflected at right angles to the main course, yet they never proceed from a culminating point: they even pass directly over mountains. But we deem it unnecessary to dwell further upon this hypothesis, not because it is absurd in itself, or destitute of facts to sustain it in its own field, but because it is inapplicable to the phenomena in this country.

We have stated some objections to two theories, which are favorites with a few geologists; but in taking this liberty, we by no means wish to convey the impression that we are confident we can propose a better theory. We have ever regarded the phenomena of drift and diluvial action as forming the most difficult problem in the whole range of geological inquiry. An expert theorist, possessing a full command of language and logic, may propose a scheme which, if put into execution according to the terms of the hypotheses and requirements, might meet the conditions required for the solution of the problem. Waves of translation, mountain high, may be demanded, that shall travel from continent to continent with hurricane speed, bearing in their bosoms the comminuted materials of the earth, and forcing along enormous rocks by the vehemence of their momentum; but the invention of a hypothesis that will plausibly account for the occurrence of a phenomenon, is a different thing from the investigation of the manner in which that phenomenon was really produced. There is a simplicity in the operations of nature, which it is well to heed. The hypothesis which we have framed, is based upon two or three facts, the principal one of which is the submergence of the northern part of our hemisphere. This submergence is proved by the discovery of the marine formation which occupies the valley of Lake Champlain, and which may be traced far south into the vallies of the Hudson and the St. Lawrence rivers, while another branch extends eastward to the Gulf of St. Lawrence. So also in the vallies and upon the coast of the State of Maine, a marine formation is found to exist. This formation was deposited after the period of diluvial action, inasmuch as it reposes upon the scored rocks, and also upon the drift in many places where it was left on the cessation of its transport. It is a formation that indicates a state of quiet after one of turbulence; for the fossils are entire, though extremely thin, and the valves often remain attached together, which could not well have happened in such shells as the *Terebratula psittacea*, if they had not been deposited during a period of quiet. The thickness of this formation is about one hundred feet; and it is now found to be three or four hundred feet above the level of the sea, preserving at this height the character of a deposit from an ocean in quietude.

Our hypothesis connects the transportation of the soils and scoring of the rocks, and the submergence of this continent, as antecedent and consequent. We might add to the former the simultaneous uplift of a continent to the north, which, displacing suddenly the waters there existing, would give them a southward movement, with a force capable of transporting all the moveable materials found in their way. A mighty rush of the waters would thus be produced, which would be competent to tear up the exposed strata, and bear the ruins along in constantly accumulating masses.

It is no part of our business here to attempt to offer an explanation of the causes of a submergence. That such a change has occurred in the condition of our continent, is a position that is borne out by many facts; not only by the existence of the marine formations of the Champlain and St. Lawrence vallies, but by the condition of all sedimentary rocks, each of which was deposited at the bottom of a sea that has long since retired, and now covers lands that formerly existed as continents or islands.

On considering the relations of the period of submergence above spoken of, we are inclined to place it in juxtaposition to that of the diluvial action, for the reason that the marine deposit is found either upon the drift, which is the product of the diluvial period, or else immediately upon the scored surface itself, which is one of the consequences of the same period. This scratched surface, where the removal of the superincumbent materials has been recently made, is as fresh as if it were made yesterday; but where it has been exposed for a few years to the action of the waters of the lake, those of Lake Champlain, the grooves are obliterated. It is then proved that these surfaces could not have been long exposed to abrading action, before they were covered and defended by a deposit.

We do not propose to enter into farther attempts to explain the phenomena of the transportation of the rocks and soils of this country; since they could amount to little more than hazardous conjectures, and perhaps we have enough of these already, although we claim to have presented a few considerations which have been too little regarded by writers upon the subject of drift and diluvial action. We think, too, that the fact that the whole body of the soil of this country is a transported soil, has not, to say the least, been sufficiently dwelt upon, and has not had its proper weight in the framing of hypotheses to account for diluvial action.

Era of diluvial action. We are now to inquire into the era of the transport of the soils and rocks. Only one opinion is known to prevail upon this question: all geologists agree in placing the diluvial period among the last of the great revolutions of the globe. We are compelled to place it before the Noachian deluge, from considerations which seem to prove that that time is too short to admit of the deposit of the tertiary of Lake Champlain, which, from its position, is proved to have been deposited posterior to the drift period. All we can say, then, is that it is comparatively a recent epoch.

Final cause of diluvial action. What was the final cause of the transaction? It may be irrelevant to the purposes of this essay, to discuss the bearing of a question of this nature; still we hope it will not be found unprofitable to offer one or two remarks upon it. As in numberless instances of less magnitude than this, we are impressed with the idea that some special design was manifested by the accomplishment of an event, some general good secured by it, and that this good had reference to the benefit of man; so we are now to seek what beneficent design is manifested, what great general good has been secured, and what benefits have enured to the human race, through the change wrought upon the surface of our planet by the mighty upheavals and subsidences and currents which have converted sea into land and land into sea. Among these benefits, no inconsiderable one appears to us to come from the mechanical effect of the drift upon the strata. Fractures and uplifts had rendered the earth's surface rough and rugged, broken and uneven; so much so, indeed, that it would have been but a sorry field for cultivation, and for the habitation of man. Hence we regard the drift period as having been designed for the purpose of polishing down the strata, and removing their roughness and their asperities; while at the same time a vast amount of new soil was produced by the same operation, and mixed and spread widely over the surface, serving to increase the depth of the soil, and fill up many irregularities which then existed.

Such we regard as an epitome of the final causes of this great and astonishing event. But are there no other instances, in the earth's history, of similar phenomena? We answer that there is at least one, or indications of one: it occurred in the era of the Trenton limestone. During the deposit of this important rock, the process of deposition was suspended, and in an intermediate period, diluvial action took place, wore down and polished and grooved its surface as in the period we have just described. This fact we were the first to observe at Plattsburgh and Cumberland head. In splitting off a layer of the limestone, we observed that its surface was smooth, and even polished, and that the inferior surface was faintly scored, and the surface taken from it presented an exact cast in relief. But it was particularly interesting to discover, on the same day, the same stratum four miles distant, in the same condition, only the striæ and grooves were much deeper than those at the village of Plattsburgh. Of the extent of this smoothed surface, we have no means of determining. We had, however, observed the same thing a few years before, thirty miles south of Plattsburgh. An interesting fact in this discovery, is, that the rock above is the same as that below. There is no change in the lithological features of the rock: neither is there any in the fossils.

III. RELATIONS OF THE SOILS OF NEW-YORK TO THE ROCKS ON WHICH THEY REST.

From what has been now said of drift and diluvial action, it may be inferred that the soils are so far removed from their parent rock, that the one upon which they now repose can not give us much light or information of their nature or composition. This is true to a certain extent; yet it is not so generally true in New-York, as in the New-England States. Here, as every attentive observer must see, is a series of rocks, in the midst of which there are many thick and heavy beds of slate and shale, and of slaty and shaly limestone, which are eminently disposed to undergo disintegration. Now we have no doubt of the statement we have already made in regard to the denudation of large areas; still, such is their inability to resist the changes of the climate, that in a few years the exposed and naked surface would be covered again with soil. In all the great divisions of the New-York system, decomposable beds occupy no inconsiderable portion of its surface. Observation fully sustains this view. A careful examination of the soil of the Onondaga-salt group shows that it is derived from the rocks beneath: it is filled with small angular fragments, where it is ploughed; and these may be observed in all stages of decay, from lumps of the size of a walnut, to a fine pulverulent soil. The same is true of the Utica slate and the slates of the Trenton limestone, and of the Marcellus shales and the Niagara green slate or shale. Hence, though a most thorough removal of the whole soil of the early periods may have taken place, yet the rocks of this State are such that they would soon be covered again by their own debris; but we by no means suppose that this remark applies to every part of the Union, or even to all parts of this State indiscriminately.

But we do not wish to be misunderstood in these remarks. It is true, that for large areas, the soil is derived directly from the rock upon which it rests; still it is not identical in composition with the rock. The rocks, when pulverized, give quite a different analysis from that which results from the soil. This is an important fact, and could not have been known except by analysis and by experiment, though such a result is in accordance with other known facts. It appears that rocks must yield to atmospheric influence, and the more so as their surface is increased; and hence upon rough surfaces the effects are far greater than on smooth ones, and still greater where the natural joints are open and admit water, which, on freezing, exerts its ordinary effects by expansion; and as these effects continue, the most stable materials are finally broken up and removed; and when completely reduced to soil, they have already lost a large part of their soluble matter, whatever it may have been. The debris is then composed of the most insoluble parts or elements, as silica and the silicates, alumina, and oxide of iron; and the probability is that all soils would, in the end, other things being equal, be reduced to about the same state. If two kinds of soil were treated with water, or washed upon a filter, the soluble matter would soon be removed from each, and they would be reduced to about the same value. The difference in the value of soils is often preserved by the natural vegetation, an effect due to the power, which vegetables possess, of taking up by their roots the soluble matter, and conveying it to the surface; and so long as a soil is covered with a natural vegetation, no matter how heavy or how rank it is, the surface grows richer. By this means a certain amount of inorganic matter, essential to vegetation, will be always preserved at the surface, provided it is not ploughed or put under artificial cultivation; for then, aside from what is removed, the ploughing and stirring of the soil exposes it to the water, which percolates through it, carrying the soluble matter from the surface beyond the reach of roots. The result then is, that a soil differs more and more from the rock from which it is derived, by gradually losing some of the elements which were contained in the rock. What the rock does not contain, will be absent from the soil, but the proportions will vary. Knowing then the composition of the rock, we only know what the soil probably contains, and what it certainly does not; making due allowance for the loss of soluble matter, which it must sustain under a course of cultivation.

The amount of material essential to the growth of good crops, can be learned only from analysis. The information to be derived from the rock beneath, embraces that knowledge which concerns the kind of elements, and not their amount, except in those cases where there is always a supply. Silex, and probably alumina and iron, are so generally diffused, that it is not difficult to determine the fact of their presence or absence by mere inspection.

One important effect which has not been fully stated in regard to the transportation of the soils of New-York, is this: the softer rocks have been made to contribute largely to those of the harder ones. The harder rocks, in the first place, resisted the force of the diluvial current; they checked its force, and hence the debris which was borne along was deposited at those places where the resistance was the greatest. It is for this reason that the north and northwest slopes are coated with an enormous depth of soil. The slopes of Livingston county have a greater amount of soil from the Onondaga shales, or Salt group, than Onondaga county itself. The wheat clays and wheat sands of Livingston came mostly from the Salt group, and the soil is deeper and more abundant than in Onondaga.

The same kind of soil bottoms the vallies far south: even the Chemung vallies are greatly indebted to the soft rocks of Onondaga for fertile soil, but it does not reach the hill-sides.

The soils of the primary rocks, especially those of Franklin county, have acquired much additional material from the Hudson-river shales of Canada; and a vast amount from the north is lodged on the northern slope of Franklin and Clinton counties, from Lake Champlain to the St. Lawrence river. It does not extend very far south, however, and most of the soil of this primary region is derived from the rocks themselves.

In proceeding, then, to the examination of the soils of a district, especially if we wish to make a comparison between them and the underlying rock, the first step is to determine whether our soil is from a drift bed, or if it is filled with many large and small rounded pebbles of some other rock; if so, we can not get much light upon the nature of the soil from the rock beneath. The pebbles, in this case, are sufficient of themselves to give some information of the probable nature and composition of the soil: if they consist of limestone, lime will probably be found in the soil; if of slate or shale, there is the same indication, though it is not so important; but if the pebbles consist of silex, or sandstone gravel, the inference is decidedly negative so far as lime is concerned. Siliceous pebbles exert simply a mechanical effect, but that effect is valuable.

IV. ELEMENTS OF SOILS.

Properties and functions of the elements in their individual and combined capacities.

Of the fifty-eight elements of matter, only about fifteen enter into the composition of vegetables, if we disregard marine plants. These fifteen elements are all found in soils, and are all necessary and essential parts of it. Each may be said to have its peculiar function: it may be entirely useless so far as it is considered an element of a particular vegetable, but highly important in imparting a certain condition to the soil. The office of these elements is twofold: first, as performing a specific function in the organization of a living body; and secondly, as giving a particular state or condition to the soil: the first office is vital, the second mechanical.

We have been considering elements, by which is usually meant a simple undecomposed body, as iron, gold, silver, oxygen, chlorine. This is not the state, however, in which they enter into the soil, or into plants; in their uncombined state, they are unsuited to either place. Hence we always find iron combined with some other element; and so also of sulphur, nitrogen, hydrogen, carbon, etc. The diamond (pure crystallized carbon), reduced to an impalpable powder, would be totally valueless as food for plants. Oxygen must at least be diluted with nitrogen, else it destroys rather than promotes the healthy functions of organic bodies; and as respects nitrogen by itself, we have no proof that it is ever received into the constitution of an organic body. We shall therefore consider the elements of soil in their compound state. Elements in this state act as simple bodies: they are homogeneous; and when they enter into combination, it has the force of a simple substance. Every particle, however minute it may be conceived to be, is still composed of the same matter. In carbonic acid, the pure carbon of the particle is inert: it is the oxygen which combines and brings about the result.

The elements, as now explained, may be divided into two classes: 1. Those which are essential to all organized bodies, and hence are called organic elements; and 2. Those which compose the inorganic world, and hence have received the name of inorganic matter. The first class numbers only four elements, namely, oxygen, hydrogen, nitrogen, and carbon. The second class comprises eleven elements, namely, silex, alumina, lime, magnesia, potash, soda, sulphur, phosphorus, chlorine, iron, and perhaps manganese.

Oxygen. When free, it is a gas, or an invisible aëriform body. Its weight is a little greater than that of atmospheric air. Its constitution is such that it is ready to combine with all other bodies; and, in the act of combining, it gives rise to one general phenomenon, termed combustion: the only difference which belongs to specific cases, is the rapidity of combination, the end or result being exactly the same. Thus oxygen combines with iron, and forms the black or red powder, frequently called the rust of iron. If the combination goes on under the ordinary states of the air, it is an invisible action; but after a few days, the surface is red, and the oxide is formed, consisting only of oxygen and iron. If, however, we contrive some means by which a rapid combination takes place, it is then accompanied with all the ordinary phenomena of combustion, the emission of heat and light; but here it is an oxide which is formed, and nothing else, and the difference of the two cases is one of time only; for, undoubtedly, just as much light and heat are produced in one case as in the other; just as much ice might have been melted by the slow combustion, or as much light emitted, as by the rapid one. So in all other cases there is a combination of oxygen with some other substance; as when wood burns, light and heat are attendant phenomena, the combination proceeding with such rapidity as to render itself both visible and palpable; but if the wood combines slowly with oxygen, as is the case when it rots, then time is required to make us sensible of the change, and yet the final result is but the reduction of the wood to the condition of an oxide as in the preceding case. The compounds which form in these and all other combinations, are called *oxides*, or *acids*, of the properties of which we will not now speak, but refer the reader to books of elementary chemistry.

Oxygen is the controlling element of both organic and inorganic matter. Few substances are known which are destitute of it; and even if the number were greater than it is, this would hardly affect the truth of the proposition. Its range of affinity is such, and so wide, that all the other elements are usually found in combination with it. Few functions in vegetable or animal life are performed without its agency. The leaves of the forest trees are spread out to exhale it, and the roots fill the soil to suck up fluids which contain it. The lungs of animals expand to absorb it, and vitalize the currents of blood. Every organ, every tissue feels its stimulus. Every thing in nature is formed with reference to it. The tiny insect and the feeble worm are subjected to its action. Every living being breathes it; and though of the cold-blooded class, no animal can subsist without a certain quantity to which its nature is adjusted: diminish that quantity, and the animal languishes and dies; increase it, and the animal dies from a too rapid combustion of its organs. Perfectly organized bodies can not withstand the effects of oxygen, if made to inhale it in a proportion greater than one to five. Inert as vegetable life seems to be, it will bear no more: neither will it survive a dose less than nature has provided for it. Rocks and soils are but oxides. One half of the solid crust of the earth is oxygen. The waters and the air are combinations of it suited to the conditions of the existence of animated nature, and these conditions are controlled by oxygen.

Hydrogen. This is the lightest aëriform body whose properties have been examined: it is sixteen times lighter than oxygen. It is combustible, and, when slowly burned, emits a pale blue flame. If oxygen and hydrogen are brought together in contact with flame, the combustion is instantaneous, and followed with a report loud in proportion to the quantities employed. The product of the combustion is water, a result which proves synthetically the composition of this fluid; the proportions being, by volume, 2 hydrogen and 1 oxygen; or, by weight, 1 hydrogen and 8 oxygen.

Nitrogen. This is a gas, remarkable, it is said, for its negative properties. It is lighter than oxygen. Under ordinary circumstances, it is but feebly attractive of other bodies, even of oxygen; and though their temperature be raised to the highest point which we can command in the furnace, they refuse to combine. If, however, the electric spark is passed through a mixture of oxygen and nitrogen, combustion ensues, and nitric acid is formed. Lightning is supposed to effect a similar combination in its passage through the atmosphere. Atmospheric air, which is considered a mixture of these two gases, contains 20 oxygen and 80 nitrogen, omitting decimals. This proportion has been regarded as indicating a chemical union; but it seems to be explained by the fact that there is no more free oxygen in the universe, by which the air can be charged so as to alter the proportion; for doubtless these two gases will mix as well in any other proportion as in that which composes the atmosphere. It is the proportion created, and to this organic bodies and beings are fitted.

The physical properties of the atmosphere are no less important than the chemical. Its height, its density, and consequently its pressure, are subject to as little variation as its composition. When in motion, its weight is diminished. It is a solvent of water, which exists in its interstices as sugar in those of water; and, like water, its capacity for solution under given conditions is limited. If the atmosphere was anhydrous, the bodies of animals would be required to be anhydrous also; but the constitution of living bodies requires a great proportion of liquids. The physical constitution of the atmosphere being determined, life, its functions, and its apparatus, are adjusted to those conditions.

Carbon is a solid. The diamond is always referred to as an example of pure carbon, because, when burned, the residue is carbon in union with oxygen. The common form, charcoal, differs but slightly from the diamond in composition, but the physical properties are quite different, although the difference is not greater than that of pure alumina and the sapphire. So it is not improbable that, like the instance here cited, the difference is due to crystallization. Carbon forms the solid parts of organic bodies, except those which are formed of the compounds of lime. In the vegetable kingdom, especially, carbon is the element which gives solidity and strength to the individual. It also enters largely into the composition of fluids, or it may be said that this state is preparatory to a conversion into the solid form. Carbon is always black when uncrystallized. Chalk and lime, magnesia, together with a great number of other bodies of the mineral kingdom, are compounds of carbon, or rather triple compounds of oxygen, carbon, and lime or some other base. Carbon is widely distributed in both the organic and inorganic worlds. It is associated with the oldest products of the latter, and is brought up from the lowest depths of the earth, and hence is as ancient and consequential as any of the elements except oxygen.

Soil without carbon, very rarely, if ever, produces perfect vegetables. The experiments which go to prove the contrary are suspicious. Soil which has been heated to redness does not part with its carbon; the acids do not destroy it; and hence those instances where it has been attempted to destroy organic matter, or the carbon in soil, may be set off against the difficulty of destroying it under circumstances more favorable. Crenic or apocrenic acids are scarcely destroyed by a red heat, when the quantity is very small; so the organic matter of soils is very rarely consumed, when brought to a bright redness preparatory for analysis.

Principal compounds of the four preceding elements.

The compounds which oxygen, hydrogen, nitrogen and carbon, form among themselves, are water, air, and carbonic acid. These will be fully treated in this place, as they are agents of the highest importance in the economy of life.

Water. Few substances are anhydrous; although it is necessary to premise that we do not here mean to employ the term in its usual sense. Some substances retain water mechanically, and, if dried, are truly anhydrous, or without water in their constitution. We mean, by the term *anhydrous*, to specify that condition of substances in which they neither contain water mechanically by absorption, nor chemically by combination. We use the word with a wider than the usual latitude; and for this reason, that so far as the welfare of either kingdom of nature is involved, the mechanical combination is as important as the chemical.

Nearly four-fifths of the matter of animals is liquid, all of which is lost simply by drying in the atmosphere at its natural temperature. Vegetable matter contains less. Wood loses, in drying, one-fourth at least; fruits and tubers, from 85 to 93 per cent; grains, from 50 to 90 per cent. Water therefore performs an essential function in organized matter.

Water is colorless, transparent, destitute of taste and smell. It is solid at 32° Fahr. if agitated; if quiet, it may be reduced still lower, and retain its fluidity; but if then agitated, it solidifies, and its temperature rises to 32°. In these changes, its bulk or volume is also altered. During the act of solidifying, it expands with great force: even its expansion begins at 40°. Water passes into steam or vapor at 212° F.; one cubic inch of water expanding to one foot of steam, or 1728 cubic inches. The boiling point, however, is determined by the pressure of the atmosphere, which, at the level of the sea, is equal to a column of mercury 30 inches high.

Water is never pure. It dissolves the air, a great number of gases, and various saline matters, as salt, sulphates, nitrates and carbonates. Where these ingredients are in excess, the waters are called *mineral waters*, and exert very frequently an important effect upon the animal system.

The foreign bodies most frequently present in water, are carbonic acid, ammonia, and atmospheric air; and when it has fallen upon the earth, and has issued again in springs, or collected in wells, the number of its foreign ingredients is increased.

Of the amount of gases which water is capable of dissolving, we may state, that according to the latest practical chemists, they stand as follows:

Sulphuretted hydrogen,	253.0	volumes.
Chlorine,	434.0	"
Carbonic acid,	206.0	"
Oxygen,	12.5	"
Nitrogen and hydrogen,	0.6	"

Although water scarcely dissolves nitrogen, yet it dissolves atmospheric air; and it is this which gives it a pleasant and lively flavor, so refreshing when compared to distilled or boiled water from which the air is expelled.

Sea water contains the accumulated soluble matters of all climes, which have been transported to this great reservoir by rivers. When this water is frozen, the salts are excluded from the ice; and hence, in high latitudes, fresh water is obtained by melting blocks of ice.

Water is the standard with which the weights of all other solids and liquids are compared: it is 1 in the scale of specific gravities. In this comparison, equal bulks or volumes are compared; thus, a cubic inch of granite is found to weigh 2½ times as much as an equal volume of water.

The atmosphere. The constituents of the atmosphere have been given. It is a body of aëriform matter surrounding the earth, and exerting a pressure equal to 15 lbs. on the square inch. The atmosphere is supposed to be acted upon by two forces, which conjointly fix its limits, namely, its own elasticity, and the earth's attraction. Refraction indicates that the atmosphere does not extend beyond forty-five miles from the surface of the earth, although some other phenomena would lead us to infer that it extends much farther.

The sun's rays, in passing through the atmosphere, do not impart to it a sensible amount of heat. They pass on to the earth and are absorbed by its surface, whence the heat again issues by radiation, and warms the lowest stratum of the atmosphere, which ascends and communicates its heat to the other layers in succession. By contact with the earth, then, the air is heated; and the farther it is removed from the surface, the less caloric it receives, till at a certain height the uniform temperature is reduced to 32°. The height at which this effect occurs, depends upon the quantity of heat which the earth receives from the sun. This is greatest at the equator, and hence the point of perpetual congelation is the highest there. Thus, at the equator, this point is 15,000 feet above the level of the sea; and from the equator it constantly approaches the earth, until at the poles it sinks below the surface.

The relations of the atmosphere to heat, form one of its most important properties. Air is ranked among the non-conductors. When confined in a space, it prevents the escape of heat. If it was capable of being heated by the transmission of the sun's rays, it would render the earth uninhabitable.

Ammonia. This compound of nitrogen and hydrogen is exceedingly important in vegetation. Some of onr most important grains require its presence. It exists in the atmosphere; and it is developed in the decay of animal and vegetable substances, from which it escapes into the atmosphere, ready to enter into new combinations. One single property of this substance fits it to play its important part in the vegetable economy, namely, its ready absorption by porous bodies. This property is manifested and proved in innumerable instances, some of which fall under observation in our ordinary manual operations; for example, plaster, when placed in a stable, or in any place where organic matters are undergoing decomposition, takes up the ammonia as it escapes: lime also performs a similar office. A direct experiment, which proves this statement, is often performed in the laboratory; thus, we have only to pass a little plaster, lime, charcoal, earth, etc., into a receiver containing ammonia over mercury, when the whole of the ammonia disappears: it is absorbed and condensed in the pores of the body employed. Any moist substance whatever produces this effect instantaneously, so powerful is the affinity of ammonia for water. The same process goes on in nature: the ammonia floating in the atmosphere is continually absorbed by soils, by humus, and especially by clay; and all these substances give out their ammonia on the application of sufficient heat to dissipate their water. Exposing fresh surfaces of soil to the air, is one means of procuring a fresh supply of this matter. Clay, and the oxide of iron contained in the soils, perform the important function of absorption. This property of clay is the one which renders clay soils so much better for wheat, than sandy soils: it furnishes a supply of ammonia, from which the wheat forms its nitrogenous matters.

Sulphur. This well known substance is widely disseminated in the mineral kingdom, and is also found sparingly in the vegetable and animal kingdoms. The two most common combinations are sulphurets and sulphates. In the former condition it is combined with the metals; in the latter, with oxygen, forming sulphuric acid. In this state it combines with earths and alkalies, and forms salts, as sulphate of lime, of soda, of magnesia, etc. It is an important substance. It is obtained mostly from Sicily, and is a volcanic product, resulting from the sublimation of a native sulphuret. It may be also procured in this State, by the roasting of certain ores in which it abounds.

Phosphorus. In its pure state, this is a white solid, highly inflammable, comparatively soft and flexible at blood heat, and taking fire readily by friction. It is quite abundant in the animal kingdom, in combination with oxygen, forming phosphoric acid, which, like the sulphuric acid, combines with lime and other bases, forming salts. The phosphate of lime is its most common combination. It is an essential constituent of bones, and of the coverings of many marine animals, forming in both cases the hard substantial part of the animal. It is also met with in the mineral kingdom. It is contained in all good soils, but only in small quantities when compared with the other elements. It exists in combination with lime, iron and alumina, and is detected with difficulty. Both phosphorus and sulphur form constituent parts of *proteine*, which is regarded as the basis of albumen, fibrine and caseine.

Carbonic acid. It is a constant constituent of the atmosphere. Its origin is not known: it is, however, a constant product of combustion and respiration, and in this way continually escapes into the atmosphere. It also escapes from the earth in the neighborhood of volcanoes; but it is here one of the results of combustion, or of the action of heat on the limestone contained in the interior of the earth. It is heavier than atmospheric air, and, hence, if operated on by its specific gravity only, would always be found on the surface of the earth; but gases, when mixed, never behave like liquids, where the heaviest finds the bottom and the lightest the top: they, on the contrary, become equally mixed, and all parts of a volume will be found to contain the same proportion of the heavier and the lighter gas.

Carbonic acid is a poison. When inhaled, death speedily follows, unless means are soon instituted for counteracting its effects. It is not simply a deprivation of oxygen. It extinguishes a burning taper if immersed in it, or even if it be simply poured over the taper. Hence by trying a suspected gas with a lighted taper, it may be known whether carbonic acid is present. When mixed with air in the proportion of 1 to 10, it still remains irrespirable, producing stupor and death like a narcotic poison. Its specific gravity is 1.52. It dissolves in water, forming an agreeable acid taste. It turns litmus paper red.

Carbonic acid is liquid under a pressure of 36 atmospheres $= 15$ lbs. $\times 36$ on the square inch. If the pressure is suddenly removed, the evaporation is so rapid that a portion of the liquid solidifies from the loss of heat.

Carbonic acid has a wide range of affinity. It is one of the important and most common of the compound elements. This importance is due partly to the ease with which it may be disengaged from the base with which it is combined; thus we have only to heat limestone, to obtain quicklime. It is a solvent of rocks and soils.

Silex. It is a solid, the purest form of which is known as rock crystal. White sand is often nearly as pure. It is hard, and, in these natural states, resists the atmospheric influences, and is insoluble in water. Its specific gravity is 2.66.

Silex or silica is a compound of oxygen and silicon: it is the only compound known of these bodies in a state of purity. Silica, in consequence of its peculiar composition, and the compounds it forms with other bodies, is regarded as an acid; and hence its combinations are termed silicates, after the manner of carbonates and sulphates.

Silex is the largest constituent of the earth. It not only forms large masses, or thick strata in the earth's crust, but it is very frequently combined with the other elements, forming with them the extensive class of bodies called silicates, as silicate of lime, of magnesia, of potash, of soda, etc.

The silicates are important bodies, notwithstanding they are apparently so insoluble. Their feeble insolubility serves an important end. Were the case reversed, and were the elements so necessary to vegetables quite soluble, they would be speedily removed from the soil; but with their present constitution, they remain and are dissolved slowly, and no faster than the necessities of plants demand.

Soils are principally silicates. They are probably more so in this country than in some parts of Europe, where chalk or some other calcareous rocks enter largely into the composition of the soil. In New-York, calcareous soils are unknown, notwithstanding large areas of limestone exist.

Silex is known by its harsh gritty feel; and where it predominates, it imparts the same grittiness to the soil. It differs in feel from chalk; the sensation in the latter case being described as *meagre*, while that from silex is sharp and gritty. It has no adhesiveness, and hence never coheres; and when its particles are fine and smooth, the mass flows like a liquid. This character in soils requires to be understood.

Alumina. Clay and alumina, although often used as synonimes, ought not to be used in the same sense. Alumina is the pure earth, the oxide of aluminum. Clay is a silicate in part of alumina, mixed probably with both alumina and silex. Alumina is white, like pure silica, but, unlike that, it is soluble in acids.

Adhesiveness is a striking property of alumina, and also of clay; hence the latter holds together the substances in mixture with it. Soils are close and compact in proportion to the quantity of clay present. In the arts, this property, or one allied to it, is highly important; for instance, a fibre of cotton, immersed in a solution of acetate of alumina, attracts the clay and detaches it from its acid: it is thus covered with a coating of alumina.

Clay or alumina, when contained in bodies or in soils, gives to them a smooth feel, which covers the gritty feel of silex. Such soils exhale the peculiar odor called argillaceous, when they are breathed upon. The excess or deficiency of alumina is indicated where a soil is wet, and it is capable of being rolled or kneaded; when there is a deficiency of alumina, the soil falls to pieces by its own weight.

LIME. Calcium is the name of the base of lime. Neither calcium nor lime exist uncombined in nature. The compound familiar to all, is lime combined with carbonic acid. Rocks of limestone are found in all parts of the earth. It is the carbonate which is necessary to vegetables, or some other form combined with an acid, as carbonate, sulphate, crenate, etc. of lime. Lime has a strong attraction for carbonic acid and water; hence, when exposed, it absorbs both, or, as the phrase is, *air-slacks*. Carbonate of lime, in a soil, operates in a mechanical way like silex: it has no adhesiveness. Lime is soluble in water, and its carbonate is also soluble, especially when the water contains carbonic acid in solution.

Carbonate of lime is known to be important to many vegetables, as it is found in their ashes. It is equally important to animals. Bones contain phosphate of lime, and the shells of the mollusca and testacea contain carbonate of lime.

MAGNESIA. It is a soft white earth, with a slight alkaline taste and alkaline reaction, both in the state of pure earth and that of its carbonate. It is quite abundant, being a constituent part of many rocks, as the dolomites, serpentine and steatite. It is a protoxide of magnesium. In the earth it is found as a hydrate, a carbonate, sulphate and silicate. It enters into the composition of the cereals. Minerals which contain magnesia have a soft feel, as soapstone. Magnesia is sparingly soluble in water, but less so in hot than cold water. It is a constituent of soils, especially those which bear fine crops of corn.

POTASH. It is derived by lixiviation from the ashes of vegetables. It is white. The common potash is a protoxide of potassium. Its affinity for water is so strong, that it is impossible to separate it except by forming a salt. In the soil, potash exists in combination with silica, forming a substance comparatively insoluble in water.

Potash is one of the essential elements of felspar: hence those rocks, such as granite and gneiss, where felspar abounds, furnish this alkali for the vegetable world. Clays and clay slates furnish it; and hence in some districts, those vegetables which require it are rarely found in their highest perfection. The elm, whose wood furnishes more potash than almost any other vegetable, flourishes remarkably on the clay bottoms of Central New-York.

SODA. This substance is a protoxide of sodium, and is formed when sodium is burned in dry air or oxygen. It is a white powder, and attracts water and carbonic acid from the atmosphere. If the protoxide is dissolved in water, it becomes a hydrated protoxide of sodium.

Soda forms important salts with acids, all of which, with scarcely an exception, are soluble, and hence it is not precipitated from solutions. This property serves to distinguish some of the salts of soda from those of potash, when it is known that one or the other is present in a solution. This negative test of the presence of soda may be safely relied upon, especially if we set fire to an alcoholic solution of the suspected salt; if soda is present, a rich and pure yellow color will be given to the flame.

Soda is employed in the manufacture of glass, and of hard soap. Soda is a milder alkali than potash, though it is still a powerful detergent.

Oxide of iron. Iron is distributed throughout the mineral kingdom. The form which is best known is the red oxide, or red rust of iron, of which there are two kinds, called protoxide and peroxide. Both exist in some soils; the first is recognized by its forming a dark greenish precipitate with ammonia. The peroxide is found in the ashes of plants, and when taken up, is combined either with crenic or phosphoric acid. The kernels of indian corn contain iron; there is, therefore, no doubt that it is an essential constituent of many vegetables.

Iron is invariably found in soils; and in addition to its use to the vegetable, the color which it imparts to the soil is of some moment. Red and brown soils absorb more heat than light colored ones: they are said to be warmer.

Oxide of manganese. Its color is black. It is not known as a necessary constituent of vegetables. It gives a blackness to meadow soils sometimes; but, so far as is known, it is a neutral body: it may impart color to the petals of flowers.

Silex composes the greatest bulk of the soil. It is the base or support of the mineral kingdom: it is here, what carbon is to the vegetable kingdom. Its properties are modified by combination. Clay is the principal substance which counteracts the openness of sand. The other elements of the soil, carbonate of lime, magnesia and oxide of iron, exert very little influence mechanically upon it; they, however, belong, as modifiers, to the siliceous compounds, rather than to the argillaceous ones.

V. CLASSIFICATION OF THE SOILS OF NEW-YORK.

The ordinary course of observation among agriculturists has distinguished several classes of soils in this State, and has recorded certain facts as associated with certain kinds of soil adapted to a peculiar practice of husbandry. Such observations have been sufficiently extended to lead to a general classification of the soils of the State. It was observed in the southwestern part of the State, that where the gravel and drift beds contained limestone, wheat could be cultivated with success, and hence it was inferred that the limestone region was especially adapted to the cultivation of this crop. Experience and observation coincided in this case, and many good observers had drawn an imaginary line between the wheat district and the grazing district. There is, however, an error in the observation, which we shall point out in the sequel, although the error does not affect the principle of the classification, as there is truly a wheat and a grazing district.

The common classification of soils is founded on the predominance of certain elements, which we have just described in the foregoing pages. Where, for example, silex predominates, the soil is sandy; and where, on the contrary, clay predominates, it is called argillaceous: a mixture of the two with organic matter, is called *loam*. To be still more specific, loams were designated by the predominance of clay or silex, and thus farmers are wont to speak of a clay loam and sandy loams. In regard to this classification, it is not pretended that it is not useful, and it may be that it is as good as the nature of the case admits. These varieties, however, are met with on almost every farm; and hence, on reflection, it was attempted to class the soils of New-York geologically, or according to the products of a section of country, although these sections consist in each case of different formations. The divisions which we have adopted seem to answer well in the territory for which they were framed, but probably may have only a trifling value elsewhere.

In New-York, it seemed to be necessary that a classification should embrace wide areas, wherever it was possible to fix upon characters that would make a proper discrimination. The subdivisions which would be adopted must of necessity be based upon facts which are generally received, and upon differences which are readily cognizable as well as practically useful. The division of the State into large sections, according to the natural products, is useful particularly in giving greater clearness to our labors in the analysis of soils. It will be found useful, were there nothing more than a simple geographical division of the State. When, however, we speak of natural productions, as wheat, for example, it is not intended to inculcate the opinion that wheat can not be grown in any other than what is termed *a wheat district*. It is supposed that it may be better grown in this than in any other district, taken as a whole; that in the favored districts, wheat-growing is a more profitable business, the grain of a better quality, and the yield more abundant than elsewhere. The same general remarks apply to every agricultural district. Grazing must be followed all over the State; but there are certain districts where the raising of cattle, and the making of butter and cheese, is a more profitable business than the raising of wheat. Some districts are well adapted to the culture of maize, which, for certain reasons, are not suitable for wheat. We conceive, therefore, that districts might be marked out, each of which should have in itself so many characters in common, and such differences as it regards others, as to be considered a distinct agricultural district.

Such agricultural districts have already been sketched out, and their peculiar characteristics briefly detailed in the first part of this volume. It may not appear, on a thorough examination, that these characteristics depend on the composition of the soil. Other conditions often determine the character of an agricultural region; these are its height, surface, and depth of soil. It is true that certain characters relating to each condition go together. A high mountainous region, and a thin and broken soil are associated in one district; and such a region, whatever might be the composition of the soil, would be unsuitable for the plow, and hence would necessarily form a grazing district. On the contrary, a level or merely rolling surface is usually coated heavily with soil, and is frequently smooth and arable, yet it might furnish fine pasturage; and though the composition of the soil might not be entirely suited to wheat, still this would not be a bar to its profitable cultivation, under a variety of circumstances which it is easy to imagine.

Labor, directed with intelligence, or guided by a full knowledge of facts, may overcome great and serious difficulties.

Each district is underlaid by rocks unknown in the others, and which in each case have something peculiar. Thus the Highland district is underlaid by primary rocks; the Eastern district, by the taconic rocks; the Third district, by rocks of the Champlain division; the Western, by the Ontario and Helderberg divisions; the Southern, by the shales and sandstones of the Erie division; the Atlantic, by sea sands. In each there enters some gelogical element, and this modifies the respective productions of the district. The classification is also geographical, and hence convenient for reference; and the geography too has its influence, which is clearly seen in the length of the winters of the northern, when compared with the middle and southern parts of the State. Height is another element that must not be lost sight of. Climate, which is intimately connected with elevation, is a complex condition, and must also be studied as one of the controlling conditions affecting the husbandry of the State.

VI. TEMPERATURE OF SOILS.

As the atmosphere has its own climate, so the soils have theirs, which is not, however, independent of that of the air, but has probably a fixed relation, and is controlled by it. The temperature of a place, if derived from observations taken just beneath the surface, would be found to vary in its mean several degrees.

The climate of the soil has not, so far as we have observed, been determined for any latitude: indeed we do not know that any observations have been made upon the subject. We shall here give a few observations of our own; they may be regarded as a beginning of an inquiry, which may result in something at least interesting if not useful. There are certain conditions of the soil, which modify its temperature, irrespective of place or height. The principal modifying condition is water. The influence of this is well known, and the popular opinion here is correct: wet lands are said to be cold; the application of the thermometer proves it, and this coldness is found to arise from a superabundance of water. The coldness in question depends upon the property of evaporation: water, in passing from a liquid form to that of vapor, takes caloric from the surrounding bodies; and hence where this process goes on rapidly, the surface will be kept cold by the loss of heat required to convert a liquid into a vapor.

The following observations were made in this city, upon soil which is always slightly shaded, or which never receives the direct rays of the sun. The bulb of the thermometer was usually placed about seven inches below the surface. The place for inserting it was opened by a shovel, but the earth was merely raised sufficiently to insert the instrument, where it remained from ten to fifteen minutes, entirely covered with earth, the air being shut out by pressing the earth down.

TABLE COMPARING THE TEMPERATURE OF THE EARTH AND THE AIR.

DAY.	HOUR.	AIR.	EARTH.	OBSERVATIONS.
		1844, APRIL.		
22	5 P M	61°	50°	Elm in full blossom. Sap ascends in the bark, as I have seen in 20 instances to-day.
23	5 P M	65	52	Wind south.
24	7 A M		50	
25	7 A M	50	46	
26	7 A M	50	48	Rain.
27	7 A M	31	40	
28	7 A M	44	42	Clear.
..	Even'g.	61	42	4 hours sun.
29	7 A M	44	41	Wind west, clear.
..	5 P M	56	46	
30	7 A M	32	41	
		1844, MAY.		
1	7 A M	51	46	
2	7 A M	60	57	
3	7 A M	58	53	
..	6 P M	58	56	Rain wet the earth, as low as the bulb of thermometer.
4	8 A M	56	53	
..	6 P M	59	55	Cloudy.
5	7 A M	50	49	Overcast.
..	8 A M	56	50	Chilly. Thermometer put 13 inches deeper.
..	4 P M	67	56	
6	7 A M	50	49	Temp. of fresh rain water 54,° fell at 4 P. M. Air 54°.
7	7 A M	48	51	Cloudy.
..	1 P M	52	50	Clear.
8	7 A M	46	46	Chilly.
..	1 P M	62	50	Clear, but some showers.
15	7 A M	46	44	
..	12 M	66	52	
..	6 P M	62	64	
16	6 A M	56	52	
..	2 P M	60	56	
..	8 P M	56	54	
17	6 P M	50	46	
18	8 A M	46		
..	2 P M	50	48	
19	8 A M	54	44	
..	4 P M	62	50	
20	8 A M	50	48	
..	12 M	56	52	
21	8 A M	46	48	
..	12 M	48	48	
..	5 P M	41	42	
22	8 A M	40	40	
..	3 P M	50	46	

DAY	HOUR.	AIR.	EARTH.	OBSERVATIONS.
		1844, MAY.		
23	7 A M	51°	42°	
..	1 P M	68	52	
24	8 A M	62	50	
..	1 P M	80	60	
..	6 P M	62	52	
25	8 A M	68	62	
..	5 P M	70	62	
26	7 A M	70	60	
..	3 P M	68	64	
27	8 A M	68	64	
..	8 P M	64		
28	8 A M	62	62	
30	8 A M	67	56	
31	8 A M	76	59	
		1844, JUNE.		
1	8 A M	56	57	
2	8 A M	66	57	
3	1 P M	67	56	
4	6 A M	46	50	
		1844, AUGUST.		
6	12 M	76	68	Depth 8 inches.
..	7 P M	68	65	
30	5 P M	69	64	Dry.
		1844, SEPTEMBER.		
1	6½ A M	60	61	Earth, morning of 2d, 58°.
..	7 P M	64	59	
4	6 A M	46	55	
..	12 M	64	56	
..	7 P M	59	58	Clear.
5	6 A M	42	51	
..	12 M	72	59	Dry and clear.
..	7 P M	62	59	
6	6 A M	41	53	Clear.
..	12 M	74	58	
..	7 P M	60	56	Clear. No wind.
7	7 A M	48	54	Foggy.
..	7 P M	65	58	
8	7 A M	50	56	Foggy.
..	1 P M	76	62	
..	7 P M	65	61	Overcast; sultry. The earth, when overcast, does not seem to lose its caloric.
9	7 A M	59	59	
..	12 M	80	62	Hot; sultry.
..	7 P M	70	62	
10	7 A M	53	59	
..	1 P M	84	64	
..	Even'g.	70	64	Overcast.
11	7 A M	64	62	Overcast; wind high SE.

TABLE CONCLUDED.

DAY.	HOUR.	AIR.	EARTH.	OBSERVATIONS.
		1844, SEPTEMBER.		
11	1 P M	72	60	
..	7 P M	58	58	
13	2 P M	70	65	
..	7 P M	66	62	Overcast.
14	7 A M	58	61	Sultry; still.
..	1 P M	76	63	
15	7 A M	61	60	
..	12 M	77	64	
..	2 P M	77	64	
..	7 P M	70	64	
16	7 A M	58	59	
..	12 M	80	64	
..	5 P M	88	65	
..	9 P M	68	64	Clear; still. Grass plat 60°; surface earth 64°.
17	7 A M	58	61½	Foggy.
..	7 P M	66	64	Clear.
18	7 A M	56	60	Clear. Earth 69° on a sunny side.
..	12 M	78	63	
..	8 P M	63	63	Wind west moderate.
19	7 A M	54	58	Clear.
..	12 M	79	62	
..	7 P M	68	62	Wind SW moderate.
20	7 A M	54	58	
..	1 P M	82	62	Windy.
..	8 P M	70	64	Slight breeze.
21	6 A M	60	62	Clear; slight breeze.
..	12 M	83	65	
..	6 P M	72	65	Wind SE.
22	12 M	45	56	Thunder with rain.
..	6 P M	56	54	
23	6 A M	32	50	Frost.
24	8½ A M	49	48	
25	7 A M	52	52	Cloudy.
26	7 A M	42	52	Cloudy.
..	1 P M	54	50	
27	7 A M	32	46	
31	8 A M	37	39	
		1844, OCTOBER.		
4	7 A M	50	49	Rain.
10	7 A M	44	45	
..	2 P M	66	50	
11	7 A M	34	44	Rained in the night.
15	7 A M	50	47	South wind.
16	7 A M	40	44	Rain.
17	7 A M	50	51	
19	7 A M	48	50	Rain moderate.
20	12 M	42	40	Clear. Wind west.
		1844, OCTOBER.		
21	7 A M	23	33	
..	3 P M	40	40	Hazy.
23	7 A M	40	42	
24	7 A M	34	40	Hazy.
25	7 A M	35	42	Clear.
26	7 A M	42	46	Night rain.
27	7 A M	46	45	Hazy.
28	7 A M	30	39	No frost.
29	7 A M	35	35	Hard rain.
30	7 A M	35	35	
31	7 A M	40	36	
		1844, NOVEMBER.		
3	12 M	49	39	
4	12 M	40	39½	
5	7, 8 A M	33	38	
6	8 A M	35	37	West wind; cloudy.
7	8 A M	43	38	
8	8 A M	40	40	Hazy.
9	7½ A M	32	36	Hazy.
10	8 A M	24	32	Clear.
..	12 M	44	35	
..	4 P M	44	38	Wind east moderate.
11	8 A M	42	38	Thunder; rain at 10 P. M. Wind east.
..	Even'g.	49	40	Earth saturated with water.
12	7 A M	36	39	Clear.
13	8 A M	42	42	
14	7 A M	28	33	Clear. Earth frozen at the surface.
16	7 A M	26	30	
17	7 A M	25	30	Clear.
..	1 P M	46	32½	Hazy.
..	6 P M	43	36	South wind all day.
18	9 A M	26	30	
		1845, APRIL.		
13	1 P M	54	44	Depth, 6-7 inches. Earth had been exposed all day to the sun.
20	7 A M	44	40	Rain and cloudy. Wind east.
21	7 A M	52	47	Clear.
24	7 A M	64	58	
25	7 P M	58	52	Rain.
27	2 P M	58	52	Hazy. Wind SE.
28	2 P M	55	48	Wind south.
29	7 A M	62	56	Clear. Wind west.
30	7 P M	56	50	Wind south; chilly.

It will be seen from the foregoing observations, that the greatest difference between the temperature of the earth and the air occurs in the spring. The earth acquires the proper temperature for the coming vegetation rather slowly, in consequence of the evaporation required in order to dry it sufficiently. In the autumn, in September and October, it seems to have acquired a stock of caloric sufficient to expend for some time without exhaustion, while at the same time it operates favorably in sustaining the proper temperature for the ripening of fruits and fall crops. There is sufficient caloric retained to preserve the temperature of the surface when the air is near the freezing point, provided the surface is covered and its radiation checked. On one occasion, the temperature of the air was reduced to 26°, while the soil beneath remained at 51°; and although a severe frost followed this reduction, yet many vegetables were preserved from destruction by the caloric which the earth had accumulated the preceding week, and which was then given off. This instance of the accumulation of heat in the soil occurred upon one of the high peaks at the head of the Delaware river, when the vegetation was just putting forth. On this mountain, the shrubs which had already leaved, or had partially leaved out, and some which had blossomed, were not in the least affected by the frost.

The accumulation of heat often preserves the roots of corn, and other crops, when the herbage is destroyed. When the temperature of the surface is 60°, we have found that maize, planted however early, comes up; while if planted when the temperature is several degrees lower, although later in the season, it will certainly rot. The temperature must reach the point of 60° in order to excite germination, which, if once secured, the grain seems to be safe, though it may not appear above ground for some time.

From a few observations which we have made, it appears that mountain soils absorb more heat than the slopes at their base.

The surface heat is often preserved in autumn by rain. In the spring, too, rains aid in warming the earth. A rain whose temperature was 54° fell when the earth was 49°, and the surface was raised soon after to 51°.

The highest temperature of the ground, which has been observed, was 72°. This temperature has been maintained with little variation for several successive days, in August, the present year, 1846. The earth acquired nearly the same temperature about the same period last year. The water of a large cistern, whose surface is four feet beneath the surface of the ground, acquired the temperature of the earth, which it has maintained during the whole period of excessive heat.

VII. COMPOSITION OF THE SOILS OF NEW-YORK.

Several methods have been proposed for the analysis of soils, each of which has its particular advantages. The method which has been followed in the New-York Survey has not differed materially from that usually followed in the analysis of a mineral. One hundred grains of the sifted soil is taken after it is dried in its envelope, and exposed to a temperature of about 300°, on a piece of glazed paper, or until the paper is slightly browned, upon a clean metal plate. The loss is set down as water. It is then exposed to a red heat, and stirred in a platina capsule, until its blackness has disappeared: thus its organic matter is dissipated. It is then boiled for half an hour in strong hydrochloric acid, or until the soil becomes light gray or white. After dilution with pure water, the whole is thrown upon a double filter, and washed till it is tasteless. The silex upon the filters is ignited and weighed, and the filters are burnt, and their ashes weighed one against the other. The filtrate is then warmed, and a few drops of nitric acid added to ensure a peroxidation of the iron. Caustic ammonia throws down the alumina, the iron and the phosphates. The precipitate is washed upon a double filter until the ammonia is removed, and then ignited and weighed as usual. When it was deemed advisable to separate the iron and alumina, caustic potash was resorted to. Frequently the whole was set down as peroxide of iron and alumina. For the separation of the phosphates, pure acetic acid was employed. From the remainder, the lime and magnesia were separated by oxalate of ammonia and phosphate of soda. Sometimes a trial for manganese was made with hydrosulphuric acid. Very few instances only occurred where even a slight trace of manganese appeared, but some of the soils of the taconic rocks gave indications of its presence. Many of the analyses went no farther than the process for obtaining magnesia. When a more exact determination of the organic matter was required, an equal quantity of the same soil was submitted to the action of carbonate of ammonia, by which the soluble organic matter was separated from the insoluble.

In many instances, however, two hundred grains of soil were infused in six or eight ounces of rain water for forty-eight hours, or even longer, during which time it was often shaken. The whole was then filtered, and evaporated in a platina capsule. When it was reduced to half an ounce by measure, it was finished in a balanced platina capsule, in which it was weighed while still warm. By this method, the true amount of soluble matter was determined in any given soil. The product was examined and separated into its components, lime, silex, alumina, etc.: even phosphate of alumina was repeatedly obtained from this solution.

In conducting an analysis, we have been sensible that great care was necessary, and that each should be carried to an exact determination of all the components, especially the alkalies, the phosphates, and the saline matters which are known to be essential to vegetables. Many persons express a doubt whether the analysis of soils is of any service at all, but we regard such an expression as altogether too sweeping in its declaration. The determination of the existence of lime and magnesia in a soil is certainly important. It is true, that so far as silica and alumina are concerned, analysis is of but little use; but every other determination is of some utility. There are, moreover, other reasons for pursuing analytical investigations of the soils of this State. No one has ever taken up the subject with reference to the soils of sedimentary rocks, the limestones, slates and shales. President Hitchcock has analyzed many of the soils of Massachusetts, and Dr. Jackson those of Rhode Island and New-Hampshire; but these are principally soils of primitive formations: they could not throw much light on those of this State; and hence we could not but feel that the work of analysis would be attended with useful results, though in many instances they were not carried out to that extreme point which often is necessary, and perhaps always ought to be desired. Then again the analysis of the rock which gave origin to a soil seemed to be equally important, and this work has been pursued as far as time and opportunity would permit. Another undertaking, which no doubt will be regarded as useful, was the analysis of the waters of the State. The mode pursued in this department will be given when we reach that subject.

One of the difficulties to be overcome, was the proper selection of specimens for analysis. The first attempt made to procure soils for this purpose, was by means of a published circular, requesting farmers, who felt an interest in the subject, to forward samples of such soils as they might suppose could be rendered useful upon their lands, or which would illustrate somewhat generally the subject of inquiry. To this circular, no response was ever made. It then became necessary to visit different parts of the State for this purpose. After some deliberation, in which some previous experience was made to bear, I determined to collect, first, new soils — those which had never been cultivated ; and secondly, old soils, under cultivation, selecting specimens of the latter from those farms where a history of the husbandry could be obtained, and usually specimens of the soil and subsoil, the former taken just at the termination of the roots of grasses, and the latter from the bottom of the furrow slice. All these soils were labelled upon the spot, and put into strong double papers. In the whole of this matter, it is plain enough that only general results could be obtained, except in particular instances ; and it may be that the majority of farmers will feel themselves just as much in the dark about the composition of their own soils, that of their farms, as they were before the present undertaking was commenced. It was, however, totally impossible to visit every town in the State. In some instances we were warranted in generalizing freely as it regarded the composition of soils over large areas. For it is perfectly evident, and the observation is borne out by trial, that the nature of the soil of an area of moderate extent is sufficiently well determined by the analysis of a few specimens ; and we think we do not hazard much in saying, that in the several districts, there is such a similarity, that the composition of their soils is well determined, and may be practically useful in the pursuit of agriculture. Hence we believe that the results of our labor may, notwithstanding we have not visited every town, much less every farm, be still found of some service to the husbandry of the State, especially if agriculturists observe, in connection with the analyses, the rocks and the nature of the drift which prevail on their estates.

1. HIGHLAND DISTRICT.

The territory distinguished by this name is separated into two portions, which are widely removed from each other. The first and largest portion may be termed the Northern Highland District, and the second the Southern Highland District. The former comprises a large territory of wild land, some of which is incultivable. It is the only part of the

State which furnishes a soil whose origin is directly from the Primary rocks. The latter district is quite limited in comparison with the former; and its soil, in consequence of a free intermixture with the soils of a secondary and transition origin, can not be considered as entitled to the appellation of a primary soil, or as one derived principally and directly from primary rocks. Both divisions of the Highland district are surrounded with sedimentary rocks, and are really islands of unstratified masses in the midst of sandstones, limestones and slates. These have at least modified the soils of the borders of the district by the admixture of foreign materials, the result of which has been to improve their character and increase their productiveness.

The primary masses of the Northern district are capable of producing two kinds of soil, according as one or the other kind of granite, from which they have originated, prevails. The first and most common kind of soil is that which is derived from the potash-felspar, or the ordinary coarse granite; the second, is the lime-felspar, which belongs to the hypersthene rock, which is made up, in a very large proportion, of labradorite. The outside of this primary highland region is principally underlaid with the former, while the central or interior is composed of the latter. All the high mountains are formed of the latter rock. They are quite precipitous, and their sides thinly clad with soil whose immediate origin is the rock beneath. The appearance and character of the surface of the rocks, when exposed, clearly indicates that the rock undergoes decomposition: it is often covered with the fine powder derived from the felspar. This rock is destitute of mica, another mineral which is common in granites, and which assists, by its decomposition, in supplying the soil with the alkalies. As lime is the principal alkali in the hypersthene rock, we must of course expect to find it in the soil formed of this rock, and the analysis of many soils of this region confirms this expectation.

The first variety of granite produces a soil which contains a larger proportion of the silicates of alumina and potash, while the soils formed from the latter variety yield a greater amount of the silicates of lime and alumina. The virgin soil of either kind produces a very large growth of grass. The wild grasses only are found in the natural meadows, which yield about a ton and a half per acre. But when timothy is first sown, or when by accident its seeds are scattered by the road side, its growth and size are truly remarkable: it not unfrequently attains a height of five feet, and its stems are as coarse as rye straw. This fact is worthy of notice; for this gigantic growth is undoubtedly due, first, to the abundance of alkaline earth in the soil, and, secondly, to the light vegetable mould in which it takes root.

Composition of the soils of the highland district.

It was not considered important to analyze a great number of the soils of this district, as we wished to learn merely their general character and composition. The samples were all selected from Essex county, inasmuch as here they are entirely of a granitic origin, without a perceptible intermixture of sedimentary rocks. A specimen of this soil, collected in Elizabethtown, is made up of coarse and fine grained particles of light-colored hypersthene rock. The finer portion was separated from the coarse by a sieve, giving about twenty per cent of finely divided matter. The analysis gave

Water	2·00
Organic matter	1·00
Silex	94·00
Peroxide of iron and alumina	2·50
Carbonate of lime	0·50
Magnesia	trace.

This soil had never been cultivated, and seemed almost valueless, but it contains about as much lime as many very good soils now under cultivation. It is a sample of the coarsest and poorest soil of the granitic district, but which might bear one, two or three crops of potatoes, or grass for a few years only, if removed from the field.

Another specimen of soil was examined from Lewis county, which gave a better result: there was less sand and silex, a greater percentage of iron and alumina, and about the same proportion of carbonate of lime. All the trials made with the granitic soils of this district yielded carbonate of lime, but only a mere trace of magnesia.

A specimen of uncultivated sandy soil from Westport, gave the following result:

Water	4·00
Organic matter	3·25
Peroxide of iron and alumina	5·00
Silex	85·25
Lime	1·00
Magnesia	0·12
	98·62

This specimen was derived also from granite or gneiss, as, under the microscope, it was found to be composed of quartz and schorl, with a few particles only of felspar, mica and garnet.

Another specimen of the sandy soil of this place gave

Water	1·00
Organic matter	2·50
Silex	94·00
Alumina and iron	2·00
Lime	0·25
Magnesia	0·00
	99·75

It is a gray sand, composed of quartz, garnet, and black schorl. The specific gravity of this soil is 2·573. We give it as an example of the weight of a soil in which sand predominates; and alhough sand is considered one of the easiest varieties to work, still it is the heaviest of all soils: a pure clay soil is next; and the loams, with much vegetable matter, are the lightest, and are light in proportion to their amount of vegetable mould.

Another granitic soil, from the same neighborhood, gave

Water	3·00
Organic matter	2·00
Silex	92·00
Peroxide of iron and alumina	2·50
Carbonate of lime	0·50
Magnesia	trace.
	100·00

Most of the granitic soils of the whole district give an excess of silex, or sand. The amount of organic matter is proportionally too small to form a durable and productive soil; but as there is frequently an admixture of materials derived from the Champlain division, its properties are improved.

The only remaining soil of this district which we propose to give is the argillaceous soil, which prevails on the borders of the lake, and in fact surrounds the Primary district. It belongs to the upper part of the Tertiary clay. Its analysis gives

Water	5·00
Organic matter	4·20
Silex	80·00
Peroxide of iron and alumina	8·25
Carbonate of lime	2·40
Magnesia	0·10
	99·95

This variety of soil gives results differing from the above in the amount of silex and lime; the former uniformly increasing towards the top, and the lime increasing towards the bottom, so as sometimes to amount to five per cent. It is durable, and bears good wheat, while the more sandy portions answer well for indian corn. It is the best soil either upon Lake Champlain or the St. Lawrence river. One of the most important improvements which can be pursued for benefitting this kind of soil, is paring and burning; a kind of process which has rarely been resorted to in this State, but which is one well adapted to clay lands. It loosens the texture, and gives solubility to the soil. But it is only where a soil has body, that this process is useful: when adopted simply to clear off vegetable matter from a drift soil, which is mainly composed of gravel, with but a small admixture of loam, it is followed with a great sacrifice, and is decidedly injurious. Hypersthene, the principal rock of the interior of Essex county, disintegrates in the manner of all felspathic rocks, and, in addition to the contribution which it makes to the general soil of the country, it also forms a clay. It is very fine, dries firmly, and may be exposed to heat suddenly without exfoliating. A few hard points, or small grains of felspar are occasionally found in it. It is quite refractory in the fire, and fuses only after urging the heat of the furnace. Its fineness fits it for looking-glass frames, forming a base on which to gild; besides which, it will undoubtedly answer for all the ordinary purposes of potter's clay. It is now used only for brick, the color of which is a pale yellow brown. It is composed of the following elements:

Water of absorption	2·284
Water and organic matter	4·240
Silex	60·160
Peroxide of iron and alumina	7·790
Carbonate of lime	0·940
Carbonate of magnesia	0·600
Carbonate of potash	0·110
Phosphate of lime	amount undetermined.
Chlorine	trace.
Sulphate of lime	none.
	76·124

The specific gravity of the Adirondack clay is 2·1034, which may be taken as a standard for stiff clays that are destitute of organic matter.

Had this clay been derived from an ordinary coarse granite, one whose felspar and mica contain potash, it would probably have formed the porcelain clay. Lime is a more stable element, less soluble than potash, and hence it has been retained, and remains in combination with the silex, or perhaps with carbonic acid. It does not effervesce with acids. The existence of this clay in the midst of this highland district offers encouragement to look for deposits of the same material in all of our other primary or mountainous districts.

The Southern Highland district, in consequence of its insulated position and its limited extent, furnishes but imperfect examples of a primary or granitic soil. On the eastern side of the Hudson river, near Peekskill, gneiss and granite prevail. In consequence, however, of the proximity of the slates and limestones of the Taconic system, the great mass of soils seem to belong rather to the latter than the former rocks: they possess at least a mixed character. We find limited areas where the primary rocks have been decomposed, and in which particles of mica and felspar abound; but we have not submitted the soils occupying such limited areas to analysis.

The following result of a chemical examination of the soil of Peekskill, resting on granite, must suffice for this part of the Highland district:

Water of absorption	2·79
Organic matter	7·65
Silex	75·83
Peroxide of iron and alumina	12·00
Carbonate of lime	1·15
Magnesia	0·68
	100·10

The following is the result of an analysis of the subsoil to the preceding, taken twelve inches below the surface:

Water of absorption	1·76
Organic matter	4·12
Silex	80·79
Peroxide of iron and alumina	12·00
Carbonate of lime	0·85
Magnesia	0·60
	100·13

It will be observed that the principal difference between the soil and subsoil consists in a greater amount of organic matter in the former, and more silex and less lime in the latter. This result, as it regards lime, has often happened; and in many instances where a deep subsoil was analyzed, and where it was expected that a greater amount of lime would be obtained, the reverse has been the fact. It appears that in the process of a natural vegetation, the lime and other alkalies are retained at the surface; but when the crops are removed, or the soil ploughed and frequently stirred, the alkalies are both removed and filtered deeper in the soil.

Another soil in the same neighborhood, taken twenty inches below the surface, gave

Water of absorption	1·13
Organic matter	3·00
Silex	81·67
Peroxide of iron and alumina	12·21
Carbonate of lime	0·83
Carbonate of magnesia	1·16
	100·00

A granitic soil, near Peekskill, gave of matter soluble in water, in 200 grains, 1·26; of which 0·71 was organic matter: the solution contained chlorides and sulphates in addition to the organic salts. Another gave 0·87 soluble matter, of which 0·46 was organic.

Since the above analyses were made, the precipitate by caustic ammonia has been examined carefully for phosphates; and in each of the Peekskill soils, and several whose origin was derived from primary rocks, they have been found. The mode of proceeding for the phosphates was as follows: The precipitate, consisting of alumina, peroxide of iron, etc., was redissolved in chlorohydric acid, and filtered to free it from any silex which it might contain. This solution was neutralized by ammonia. Acetate of potash was then added, which gave a yellowish precipitate, consisting of the phosphate of the peroxide of iron, which becomes darker by exposure to light. The quantity was sufficient to have been weighed; but as the object was merely to ascertain the fact of the existence of this substance in the soil, the quantity was only estimated.

2. TACONIC DISTRICT.

The texture of the soils of the Highland or Primary districts is coarse, and the quantity of finely divided matter is evidently deficient. The soils derived from the Taconic rocks are finer than those of the Primary, and, as will appear, have been found to contain a greater proportion of finely divided matter, and yet they are inferior in this respect to the soils of Central and Western New-York, which are derived from rocks of a later date. The cause of the difference observed between the texture of the soils of these districts, is to be sought for in their origin. The first are derived from hard rocks, only a small proportion of which decompose rapidly; while the latter are derived from sedimentary rocks, more susceptible to atmospheric influence; and hence they not only disintegrate more rapidly, but undergo, or have undergone, a more thorough change. If there were no other differences in the soil than that of texture, that which contained the greatest amount of finely divided matter would possess an advantage over the coarse or primary soils. One cause of superiority consists in the power which finely divided matter possesses, in the facility of absorption of the floating gases of the atmosphere. Finely divided platina will absorb and condense hydrogen so rapidly and copiously, when blown upon it in a stream, as to beget a red heat, and inflame the gas instantaneously. Charcoal absorbs most kinds of gaseous matter. Fine soils readily absorb carbonate of ammonia from rain water; a fact which has been long known with respect to the finer clays. The absorption of ammonia is indeed an important fact, and we have often detected it in common soils when they have been submitted to the action of rain water. The amount which a given soil can absorb and retain, is proportional to its amount of finely divided matter. The ammonia is undoubtedly often combined with the organic acids, the crenic and apocrenic. Ammonia itself operates favorably on the organic matter of the soil, the rationale of which is illustrated every day in the laboratory, where it is employed in dissolving out the organic matters. Clays contain the largest proportion of this substance, undoubtedly absorbed in solution with water. Even anthracite coal contains a large amount, which has been stored up for ages, and is separated from it when water is thrown upon an ignited mass.

There is another fact which may be noticed here, namely, that although loams and porous soils must receive from rains the same amount of ammonia as the finer soils, they have less ability for retaining it, or at least for storing it up.

The first inquiry in regard to the soils of this district, respects their chemical constitution. In pursuing this subject, it has been found that though some differences exist, still they are not remarkably different: they appear to belong to one class, and to possess essential characters in common. Some of the differences observed in crops arise from elevation, or the combined effects of elevation and other causes connected necessarily therewith. To preserve order in the several statements of the analyses, we shall begin with those upon the eastern border of the State, adjacent to Connecticut, Massachusetts and Vermont.

Soil of Petersburgh, Rensselaer county.

This soil bears about two tons of hay to the acre; rock a coarse slate, but rests upon an intervening hardpan from twelve to eighteen inches below the surface; height 1200 feet above tide at Albany; color brownish drab; cultivated meadow. It contains

Water	4·50
Organic matter	4·00
Silex	81·78
Alumina	3·70
Peroxide of iron	4·00
Phosphoric acid	0·02
Magnesia	0·50
Sulphate of lime	0·15
Carbonate of lime	0·75
	99·40

Soil of Chatham Four-corners.

In corn; fine and heavy growth.

ANALYSIS.

Water	3·50
Silex	76·00
Vegetable matter	8·50
Alumina	3·50
Peroxide of iron	7·10
Carbonate of lime	0·75
Magnesia	0·50
Phosphoric acid	0·02
	99·87

Manured with stable manure. Neither potash or soda sought for. The soil is based upon hardpan eighteen inches below the surface. It is one of the most productive soils of this district, and corn and oats and peas are always sure crops: it is also productive in grass. Wheat in large crops was formerly raised in this neighborhood, but has been mostly abandoned on account of the fly.

Soil from the range of hills near the Western Railroad Depot, at the State line.

Uncultivated.

ANALYSIS.

Water	4·10
Organic matter	6·25
Silex	78·75
Alumina	4·85
Peroxide of iron	4·45
Carbonate of lime	0·75
Magnesia	0·75
	99·90

This range of country is the most broken of any in the county. In the vallies the land is valuable, but the soil is too cold without draining. The Sparry limestone traverses this range north and south, but the effect on the soil is too small to be appreciated: the slate predominates. Besides, the productiveness is diminished by height, as well as a coarse soil. Peat and lime, which are abundant through the whole range, may be considered important means for ameliorating the soil.

A remarkable substance was brought to us from Columbia county, for examination, in the fall of 1845. It was supposed to be a valuable material, and the finder made a secret of its locality. It was, however, nothing more than vegetable matter in a fine state of division, and, as we found on examination, mixed with a little silex and alumina. It was a thick pulpy mass, some of which, as we were assured, had been thrown out of the bog upon a dry soil, and had remained wet the whole season; and about half a pint remained two months in an open tin cup, in a warm dry atmosphere, before it became dry, at which time it had shrunk to the size of a butternut. We notice this substance, for the purpose of calling attention to the fact, that some materials, combined in certain proportions, are more absorbent and retentive of moisture than others. In this substance water existed in great excess. On analysis, it gave

Water	89·75
Vegetable matter	3·45
Silex	3·55
Alumina	3·20

The silex was principally composed of the cases of infusorials.

Soil of Hoosic-corners.

Rests on fine slate; associated with ranges of limestone.

ANALYSIS.

Water	4·25
Organic matter	12·69
Silex	69·78
Carbonate of lime	1·76
Magnesia	1·30
Phosphate of alumina	1·15
Peroxide of iron	5·55
Alumina	3·42
	99·90*

* The notes relating to this remarkably rich soil were lost, or the facts forgotten. It is, however, well known that the soil of Hoosic is excellent. This was probably a new and uncultivated soil.

Soil of Hoosic-falls, from the farm of Judge Ball.

ANALYSIS.

Water	2·00
Organic matter	7·12
Silex	78·77
Lime	1·00
Magnesia	1·02
Phosphate of lime	0·12
Peroxide of iron and alumina	8·81
	98·97

An uncultivated soil near Hoosic-falls.

Derived from the decomposition of an impure limestone. It forms a brown earth, upon which forest trees grow rather luxuriantly; slope to the east; exposure warm; surface dry. It forms an excellent soil for corn.

ANALYSIS.

Water	3·00
Organic matter	5·50
Silex	78·20
Peroxide of iron and alumina	10·52
Carbonate of lime	1·52
Magnesia	0·33
	99·25

Soil from East-Salem.

This soil bore a fine crop of oats, and is filled with pieces of dark-colored slate. It is a soil common to the long range of hills of Washington county: it lies west of the Sparry limestone, and is much the same in quality with the soil of the range of hills east of Hoosic Four-corners, except that the quantity of broken slate is greater.

ANALYSIS.

Water	3·50
Organic matter	6·00
Silex	79·00
Peroxide of iron	5·75
Alumina	4·20
Magnesia	0·75
Carbonate of lime	0·87
	100·07

Phosphoric acid, in combination with peroxide of iron, lime, magnesia or alumina, has usually been found in the soils of this range of hills. Potash and soda have not been sought for. The chloride and sulphate of lime are also invariably present. The organic matter is also in combination with lime and other bases, varying from one to two per cent.

Soil from the western part of Schodack, in Rensselaer county.

ANALYSIS.

Water	4·25
Animal and vegetable matter	6·75
Silex	79·75
Peroxide of iron	2·75
Alumina	4·50
Lime and magnesia	0·50
	98·50
Loss	1·50
	100·00

Analysis of 100 *grs. Roofing slate.*

Water	0·50
Organic matter	2·20
Silex	80·72
Peroxide of iron and alumina	12·76
Carbonate of lime	1·76
Magnesia	0·40
	98·34

Analysis of 100 *grs. of Welch slate.*

Water	0·34
Organic matter	2·30
Silex	78·76
Peroxide of iron and alumina	16·64
Carbonate of lime	1·36
Magnesia	0·52
	99·92

The slates of this district, we believe, always contain magnesia, as well as the limestones, some of which, it is well known, are true dolomites. Hence magnesia is always found in the soil, and it does not seem to be removed so readily as lime, being less soluble; and hence, too, in a few instances where the soil has been cultivated, magnesia is present in a greater proportion than lime.

Soil near Fitch's point, Salem, Washington county.

Uncultivated; reddish brown.

ANALYSIS.

Water	1·00
Vegetable matter	2·50
Silex	87·00
Peroxide of iron	5·20
Alumina	3·05
Manganese	0·25
Carbonate of lime	1·00
	100·00

This is a local soil, derived from silico-ferruginous rock, in which there is sufficient lime to effervesce; but a large proportion of the lime is lost when it has disintegrated. It is a warm soil, upon which the herbage is sweet; and were it extensive, it would form the best of grazing lands.

The soil of the plains about Salem is mostly drift, in which cobblestones of Potsdam sandstone are quite common. It is rarely sufficiently tight to retain manures well, and yet they are not excessively leachy. Fine crops of corn are raised upon these lands; and the slopes of the hills form excellent grazing grounds, being dry and warm.

Soil of the plains and meadows at Fitch's point.

The farm of Dr. Fitch has been long under cultivation; and the meadow, being at some distance from the barn, has received but little manure.

ANALYSIS.

Water	3·50
Organic matter	9·25
Silex	77·50
Peroxide of iron and alumina	7·12
Carbonate of lime	0·10
Phosphate of lime	0·06
Magnesia	0·50
	99·03

Soil in Washington county.

ANALYSIS.

Water of absorption	7·18
Organic matter	6·12
Silex	79·72
Peroxide of iron and alumina	6·12
Carbonate of lime	0·10
Phosphate of lime	0·06
Magnesia	0·50
	99·80

Soils lying towards the Hudson river, western part of Schodack.

ANALYSIS.

Water	3·50
Organic matter	6·00
Silex	79·75
Peroxide of iron	5·75
Alumina	4·25
Carbonate of lime	trace.
Magnesia	0·75
	100·00

Soil from Schodack.

Sandy; color yellowish brown.

ANALYSIS.

Water	2·07
Vegetable matter	6·05
Silex	85·05
Peroxide of iron	4·87
Alumina	1·75
Lime and magnesia	trace.
	99·79

A variety of this soil is found in the black sand of the drift, in which one-fifth is coarse gravel, and the remainder a fine sand in which the alumina is still less than in the preceding example. It contains 4 – 5 per cent of vegetable matter, but which, on cultivation, soon disappears. It is a poorer variety than the yellow sandy loam.

Soil from the western slope of Petersburgh mountain.

Uncultivated, and containing undecomposed slate.

ANALYSIS.

Water	2·00
Organic matter	2·75
Silex	85·00
Peroxide of iron and alumina	6·75
Carbonate of lime	3·00
Magnesia	0·50
	100·00

The Sparry limerock traverses the base of this slope. The only fact worthy of notice about this soil, is the large percentage of lime which it yields. It is probably local, and its general character indicates poverty rather than fertility. In some parts of Petersburgh hollow, however, the soils are excellent.

We give here the results of an investigation of the amount of soluble matter contained in several specimens of the soils of the Taconic district, as determined by exposing two hundred grains to the action of eight ounces of rain water for several days, during which time the solution was frequently agitated.

Yellowish loam from Schodack.

Matter dissolved	2·00
Saline matter	1·44
Organic acids	0·50

The saline matter consisted of the chlorides of lime and magnesia, and the crenate of lime.

Another specimen from the same neighborhood.

Soluble matter	1·97
Saline matter	0·50
Vegetable or organic matter	1·47

Contains chloride and sulphate of lime, crenate of lime, and magnesia and ammonia. When these vegetable salts are tested with chloride of platinum, a light yellowish precipitate is obtained, which was first supposed to be chloride of potassium, but I now believe it is an ammoniacal salt, or a mixture of the two. This result is almost as constant as those for lime and chlorine.

Specimen from a grass land in Chatham.

Whole soluble matter	1·03
Saline matter	0·62
Vegetable matter	0·41

Another specimen.

Soluble matter	0·75
Saline matter	0·43
Vegetable or organic matter	0·26

A reddish soil, of local formation and quite recent.

Many additional trials were made for obtaining the soluble matter. It is evident that by this method we obtained what is available to plants at the present time. The solutions, after standing a proper time, are filtered until perfectly transparent. It is necessary, in some cases, to filter three or four times, before the solution can be rendered sufficiently pure for determination. It is first evaporated in a porcelain dish to about half an ounce: it is then transferred to a balanced platina crucible, in which it is completed, and then weighed. It is afterwards exposed to a red heat, when it loses its organic matter, and is then weighed again while hot: the loss indicates the vegetable matter consumed. Before the last operation, the behavior of the saline mass shows the presence of the crenates by the effect of acetate of copper. The presence of the organic salts is interesting and important.

Alumina, silex, magnesia, lime and ammonia, are the bases most generally present. None of these solutions have shown an alkaline reaction. The quantity of saline matter obtained by this process is less than that procured from the soils of Western New-York, and it appears that the fertility of the soil bears a relation to the quantity of saline matter contained in it. The action of the atmosphere and water continually brings more of the organic matter into a soluble state.

Waters of the taconic district.

We have likewise analyzed some of the waters of the Taconic district, which are usually set down as hard waters, and the results are as follows:

Well water in Kinderhook village.

Soluble matter in one pint	1·92
Organic or vegetable matter	0·92
Saline matter	1·00
	1·92

The saline matter is composed of chloride and sulphate of lime, together with the organic salts consisting mostly of crenate of lime. This is probably purer than the water of the district usually is, and it forms an excellent beverage. It was taken from the well of Judge Burt.

Water from the village well of Kinderhook.

Saline matter in one pint	1·34
Vegetable matter	1·00
	2·34

The springs which issue from the Taconic hills, and which have their origin mostly from the slate, yield comparatively pure water, which frequently contains less than five grains of solid matter to the gallon. The chalybeate springs are weak, and issue from those slates which are charged with pyrites.

Another class of springs, though but few in number, are the nitrogen springs of Hoosic and New-Lebanon. The water is soft, but their temperature is above the mean of the place where they are found. They issue, it is supposed, from rents or lines of fracture, and come up from a great depth: hence their elevated temperature. These springs are large, but they are unlike those which issue suddenly from beneath the surface in many parts of the West, and which are regarded as subterranean streams that have just found a place for exit, after having run for miles just below the surface: these do not acquire a high temperature, but are usually quite cold.

The waters, then, of the Taconic range, are merely the moderately hard waters of a slate and limestone district. Those which issue from clay beds contain more lime, and those of a sandy district are soft, while those which issue from the slate rocks are charged moderately with iron.

The water of a spring at Hoosic falls contained 1·48 grains of earthy and vegetable matter in solution. It gave

Organic matter	1·00
Carbonate of lime	0·36
Magnesia	0·48

In addition to these substances, there may be added a small amount of chlorine and sulphuric acid.

Nature of the surface of the taconic district.

The condition of the surface of a country exerts a modifying influence upon its agricultural productions: some being developed only in high situations, and others only in low ones; some in rocky localities, and others in the rich level alluvions and plains. Steep and stony or rocky lands are devoted to pasturage, while the farmer seeks out the level tracts for his meadows and his grain-fields. Oats and peas, as well as grass, may be cultivated in regions more elevated than those adapted for corn.

The direction in which mountains and hills range is not a matter of indifference to the agriculturist. A ridge running east and west has one cold side, while hills running north and south receive the light and heat of the sun more equally, and yet the western slope is not so well esteemed as the eastern. The dawn of the morning sun quickens the fluids of vegetables: their vitality is awakened at an early hour in the day, and the impulse prolongs its effects to the setting sun; hence, to the vegetation on the eastern slope, the day is longer.

The mountains and hills of the Taconic district pursue a northerly direction. The Taconic range forms the dividing ridge between New-York and Massachusetts. Its height is from twelve to sixteen hundred feet in the bounds of New-York. It is a slate ridge, with a granular limestone at the eastern base and a sparry limestone at the western base. All the ridges, whether high or low, have a direction parallel to the main ridge dividing the two States. These minor ridges are also composed of slate, and the limestones usually occupy the vallies, as well as the sides of the mountains farther east and adjacent to the Primary system.

Proceeding westward from the main range of the Taconic mountains, their height and steepness diminish to the Hudson river, and there are no elevated plains. The principal plains border the valley of the Hudson, and are rather sandy, with an underlay of clay.

The arrangement of the hills of this district is such as to favor vegetation, and to admit and even invite useful improvements in draining and irrigation. Generally the slopes are gentle, but steeper upon the western than the opposite side. The hills are susceptible of cultivation to their very tops, and are not broken by the rugged outcropping of rocks (See the woodcut on page 79, which illustrates the contour of the Taconic hills, their arrangement, etc.; and for the higher and sub-alpine region, see Plate xiii.). The sub-alpine region is thirty-five hundred feet above tide, but is covered by a dense vegetation; and in the highest part of the region, the spruce and canadian balsam abound.

Climate of the taconic district.

From the great extent of this district, some constant difference of seasons must prevail in it; and some difference will also be found to exist, when the higher situations are contrasted with lower ones in the same latitude. One or two remarks will exemplify our meaning. Williamstown in Massachusetts, and Lansingburgh in New-York, are nearly on the same parallel: Williamstown is elevated about eight hundred feet above tide level, and Lansingburgh but thirty feet; the mean temperature of the former place is 45°·59, and that of the latter 48°·17. Again, Poughkeepsie, at the point where the observations were made, is in 41°41′ north latitude, and has a mean temperature of 50°·74. The difference of observed mean temperatures, then, between the most southerly and northerly points of the district, is 5°·15, the range of latitude being 2°11′. For further particulars in regard to climate, see Chapter III.

Quantity of rain in the Taconic district. Few observations have been made in this important inquiry, and hence only a few statements can be offered in this place. The average quantity of rain which fell in Kinderhook, Columbia county, for nine years, was 35·55 inches; in Mount-Pleasant, 23·31. In 1832, in the latter place, 53·46 inches; and in 1834, 40·97 inches of rain fell. In Granville, near the northern termination of the district, 28·88 inches fell in 1844; and in Lansingburgh, 26·94 inches.

Suggestions arising from the anlyses of the soils of the taconic district.

1. The silex, when separated from the alumina and oxide of iron, is often in the form of fine grains, or hyaline grains of sand, derived from the milky quartz of the slates, or from the sandstone of the Taconic system. What is set down as silex, then, is quartz in grains, and this performs merely a mechanical office in the soil. Another portion consists of silicates of the alkalies, which remain undecomposed by the acids employed in the analysis.

2. The peroxides of iron and alumina exist in the soils in a large proportion, though the soils are by no means clayey. We obtain as much alumina frequently from these soils as from the tertiary clay: they are far removed, however, from this clay in texture, though the proportion is as great as has been stated above. This is a good feature, and indicates a durable soil, and one upon which manure may be expended without an annual loss.

3. These soils, without exception, contain less lime than is requisite to form the best and most productive kinds of land. Magnesia, which has been found in every analysis of these soils, may be regarded perhaps as sufficient: it is less soluble than lime, and hence it remains longer; and, besides, it is furnished by the decomposing slates in quantities sufficient for the purposes of vegetation.

4. The phosphates, though usually present in some form or other, are in too small a

measure to meet the demands of a vigorous and healthy vegetation. A similar assertion may be made in regard to potash: in a few instances we have found it; in others, it has been doubtful.

Means for improving the soil of the Taconic district.

It is needless to urge the importance of making or saving all the excrements of cattle, in their best and most valuable condition for manure. The best materials for increasing the quantity of manures of this district, are *lime* and *peat*, of each of which there is an abundance. These materials are both wanted on every farm, without exception: it is proved by the analysis of every variety of soil in the district. They should be composted, which is the only way they can be profitably employed. A very useful addition to this compost, is either leached or unleached ashes, inasmuch as there is a deficiency of potash in the soil to meet the demands of the cultivated crops. Leaves, also, and all refuse organic matters, should find a place in the compost heap.

The soils of the Taconic district are rarely excessively leachy, but some are moderately so. For a leachy soil, it is proper to make a bulky manure, consisting of burnt clay, ashes, peat, or organic matters, the whole of which is only moderately soluble, but, when exposed in a porous soil, it receives the influence of the air to bring it with sufficient rapidity to a state fit for the consumption of vegetables. In a close and compact soil, the solubility of the manure may be greater; for then it may be retained for the future use of plants, if not required immediately.

Generally the basis for improvement in the Taconic district is excellent, there being sufficient tenacity in the soil to hold manure, and not so much sand as to dry up in midsummer when there is a temporary suspension of rain. Scarcely a field is met with which bakes and cracks, if it is properly treated. A defect which is general, is found in the texture, which, compared with the western soil, is considerably coarser. This defect is partially removed by frequent hoeing, which exposes a fresh surface of soil to the atmosphere.

What are called *cold lands* are not uncommon in this district. They lie on the slopes of hills, frequently two or three hundred feet above the vallies. This condition is produced by the agency of many springs, which issue from the hill-sides, and saturate the earth with water, in the shape of small fountains which percolate through the soil and subsoil on their way to the valley below; but this evil may be cured by draining.

We may remark here that the soils of this district require draining more frequently than western soils, especially when situated upon sloping surfaces, in consequence of the peculiar structure of the underlying rock. In the Taconic district, it is invariably placed edgewise, or at an angle varying from 15° to 30°; and the layers or strata are compacted so closely, that water seldom or never finds its way into the rock, and hence must pass through the soil; and if this is not very porous, the water passes off slowly, and frequently is detained so long that the soil is most of the time saturated with it.

We are satisfied, that of all the means of improving the soil of this district, drainage is one of the most efficient. It is frequently found most useful to drain only the low lands in other parts of the State: this arises from the open condition of the natural joints of the underlying rocks, which permits the water to pass below the soil, and out of its reach. But the joints of a slate, when standing upon its edge, retains the water, or at least it must pass over it and not into it; and hence, as we have already hinted, lands thus situated must be drained artificially, if it is proposed to render them productive.

The succeeding soils partake decidedly of the qualities of those which belong to the Taconic district; but as they generally prevail and rest upon granite, I have given them in this place. They will exhibit a contrast with those below, which are decidedly granitic, but quite local.

Surface soil of Peekskill.

ANALYSIS.

Water of absorption	2·10
Organic matter	3·70
Silex	87·50
Peroxide of iron and alumina	6·60
Carbonate of lime	0·30
Magnesia	trace.
	100·20

Soil on the west side of the river at Caldwell.

ANALYSIS OF FIFTY GRAINS.

Water of absorption	0·47
Organic matter	1·17
Silex	41·92
Peroxide of iron and alumina	5·02
Carbonate of lime	1·50
Magnesia	a trace.
	50·08

This is a coarse soil, and contains many pebbles of gneiss; color brown.

Brick clay below Caldwell.

ANALYSIS OF TWENTY-FIVE GRAINS.

Water of absorption	0·29
Organic matter	1·38
Silicates	16·40
Peroxide of iron and alumina	4·63
Carbonate of lime	2·23
Magnesia	a trace.
	24·93

3. HUDSON AND MOHAWK DISTRICT.

It may not appear, at the first view, necessary to treat of the soils of these vallies under a separate head. It will be observed, however, by those who take time to consider the subject, that the formation upon which they rest differs in many respects from that of the Taconic slate district. The slates or shales are more decomposable, more calcareous, and the beds of limestone are more extensive, especially if we include, as we propose to do, all the country over which the rocks of the Champlain division prevail. Hence we expect the soil contains more lime, and is in general more favorable for agriculture. The rocks too are less disturbed, and remain nearer their original position. Leaving all essential differences out of view, it will be found convenient to preserve this district distinct from the others.

The boundaries of this district are intended to run nearly parallel with the rocks of the Champlain division. It therefore surrounds the Northern Highland district. Some of its best portions lie in Jefferson and Clinton counties, where the soils are really derived in the main from the rock upon which they repose. It is of course intermingled with granitic debris in the valley of the Mohawk, especially between Amsterdam and Littlefalls.

This district contains a distinct formation of clay and sand, which imparts a peculiar character to it, and hence approximates to those of the western wheat district. This formation gives a degree of stability to the soil, which is not possessed by the soils of the hilly districts of the southern tier of counties, or even by those of the Taconic district.

The geographical position of this district, and the relations which it bears to the adjacent ones, which have been already noticed, takes from it those peculiar characters which would, in other circumstances, distinguish it. The Taconic slates border the long northern valley of the Hudson river and Lake Champlain, and hence furnish no small amount of debris or soil. The Northern Highland district, lying north of this, furnishes also its own materials especially to the Mohawk valley. If insulated, the soil of the Hudson and Mohawk district would contain a greater amount of calcareous matter. Where the soil of limestones and slates is unmixed, it effervesces perceptibly with acids; but generally in all those places where the soil is mixed with the northern primary, or with the taconic, it contains only a small percentage of lime. The mixture, as in most other instances, is due to diluvial action, or to that northern current which swept over the whole country from north to south, bearing along soil, gravel, rocks, etc. The principal difference which prevails between the soils of this and the adjacent districts, consists in the fineness of the former soil.

This district is designed to be coëxtensive with the Champlain division, a series of rocks commencing with the Potsdam sandstone, and ending with the shales of the Hudson river, or the Loraine series. A very large proportion of the Hudson and Mohawk river valley is underlaid with shales, some of which are calcareous and magnesian. The northern parts of the district, especially those lying in Jefferson and Clinton counties, contain large tracts of limestone, some of which is magnesian. The shape of the district is quite irregular.

One of its most important features is the occurence of an extensive bed of clay, and its accompanying sands. It is quite impossible to arrive at a satisfactory conclusion in regard to the origin of this formation. The shales and slates of the Hudson river, when they decompose, form a clay; and in the sands, we often detect, with a microscope, small particles of anthracite, which substance is known only in the Calciferous sandstone, and in disseminated particles in some of the Hudson river shales. These facts taken by themselves, together with the large amount of calcareous matter the clay contains, seem to indicate that the clays and sands originated from the rocks of the Champlain division. In many places, however, the magnetic iron sand is quite abundant, which can only be derived from the primary. These combined facts lead us to infer that both systems of rocks furnished materials for the formation of the clays and sands of this district. Hence it would seem that a part of the materials under consideration were not transported far, but were derived from rocks in the immediate vicinity of the deposits themselves.

We propose to begin our analyses with the soils of the Mohawk valley, in which we find those that may be considered as characteristic of the district, or that may be taken as representatives of the general composition of its soil.

Soil of De Groff's flats, between Amsterdam and Fonda.

ANALYSIS.

Water of absorption	4·50
Vegetable matter	7·37
Silex	78·83
Peroxide of iron and alumina	6·50
Carbonate of lime	2·00
Phosphate of lime	0·03
Magnesia	0·40
	99·63

The flats from which this soil was taken, are probably as productive as any in the Mohawk valley. The soil is dark colored, from the large amount of vegetable mould upon and near the surface. It is underlaid by the Utica slate, fragments of which are scattered through the soil to a considerable depth. Notwithstanding this, it may be properly considered an alluvial soil.

On ascending from one to four hundred feet above the meadows or flats of the Mohawk, we are able to distinguish soils of a different character, and differing from those below in composition. Thus, four hundred feet above the Mohawk river, at Fonda, the soil is composed as follows:

Water of absorption	3·25
Vegetable matter	4·20
Silex	84·40
Peroxide of iron	4·11
Alumina	2·63
Carbonate of lime	0·75
Magnesia	0·65
	98·99

Soil of Tribe's-hill.

Derived directly from the Utica slate, and filled with fragments of the same; effervesces slightly with acids.

ANALYSIS.

Water of absorption	4·00
Black organic matter	10·50
Silex	74·80
Peroxide of iron and alumina	6·40
Carbonate of lime	2·08
Sulphate of lime	1·20
Magnesia	0·40
	99·38

Soil taken from a hill about four hundred feet above the Mohawk in Amsterdam.

ANALYSIS.

Water of absorption	4·50
Organic matter	4·75
Silex	79·50
Peroxide of iron and alumina	8·40
Carbonate of lime	1·09
Magnesia	0·40
	98·84

Soil four miles west of Littlefalls.

Cultivated meadow; surface soil.

ANALYSIS.

Water of absorption	4·00
Organic matter	12·00
Silex	71·78
Peroxide of iron and alumina	10·25
Phosphate of lime	0·07
Carbonate of lime	1·50
Magnesia	0·40
	100·00

Analysis of four specimens of soil from near the village of Rome, furnished by B. P. Johnson.

The accompanying letter explanatory of the soils, is copied into this report. The country in the vicinity of Rome is underlaid by the shales and sandstones of the Hudson-river series, or the upper members of the Champlain division of the New-York rocks. The cobblestones spoken of are of the usual size of paving stones, and are derived principally from the Potsdam sandstone and the gneiss of the Primary district surrounding the head waters of the Black river. In the neighborhood of Rome there are extensive tracts of peat lands, frequently accompanied with marl, beneath which is the boulder system composed of the cobblestones spoken of above. The depth of the peat and marl varies much at different places; sometimes there is merely a foot or two of peat resting on the drift bed, but at other points it is ten to fifteen feet deep. These lands, as they remain at present, are cold, and not productive of the valuable grains or grasses, but they contain an inexhaustible supply of organic matter for compost, which we hope will be employed in correcting the soils of this neighborhood at no distant day.

LETTER FROM B. P. JOHNSON.

Prof. E. Emmons, *Rome, July* 3, 1845.

Sir — I enclose you two specimens of soil, taken from my land in this town, near the village of Rome. The land is the first rise of land above the Mohawk flats, and is mostly of the character of the samples sent you. This land is, to a considerable extent, covered with cobblestones, and they extend some distance below the surface. It is very productive usually, and is especially favorable for corn.

Formerly wheat was extensively cultivated here, but, of late years, not to any very great extent, though excellent crops are still grown, when the seasons are favorable, and when the grain escapes the ravages of the fly or "wheat midge," an insect somewhat resembling a gnat. This fly is what is frequently called in this country the "weevil," though entirely distinct from it.

The Mohawk flats, which extend to a considerable distance from the river, are of the same character as the flats lower down, in Herkimer and Montgomery counties: they are very productive. We have another character of soil in this town, on land still more elevated, composed generally of gravel and loam, which is good and productive land.

I enclose you also two specimens of soil from the land of Henry Huntington, Esq., near this village.

We feel a deep interest in the agricultural survey which you have been making, and we anticipate very beneficial results to the farming interests of the State. It is of vastly more importance than has generally been supposed, to the farmer, that the composition of his soil should be known, and the kind of manures best adapted to it pointed out: so also as to the crops best suited to it. I have long been satisfied that one reason why so many experiments have either wholly or in part failed, has been the want of attention to this subject. I shall be disappointed, if, from your varied experiments, great good does not result: it can not, I think, be otherwise. Nothing so readily does away prejudice among farmers, as facts which are presented to them from actual experiments.

There is much yet to be done in this State, before we shall be fully prepared to develope the abundant resources of our soil. It is, however, very gratifying to witness the advances which are making: they are such as to encourage every one interested in the subject, to persevere until the great work is fully accomplished.

Wishing you every possible success in your labors, I am, very respectfully,

B. P. JOHNSON.

ANALYSES OF THE SOILS FURNISHED BY MR. JOHNSON.

SOILS FROM THE FARM OF MR. HUNTINGTON.

NO. I.

Water of absorption	4·00
Organic matter	8·00
Silex	76·00
Carbonate of lime	3·60
Magnesia	0·12
Peroxide of iron and alumina	8·30
	100·02

NO. II.

Water of absorption	3·75
Organic matter	4·25
Silex	84·00
Carbonate of lime	2·50
Magnesia	0·15
Peroxide of iron and alumina	5·50
	100·15

SOILS FROM THE FARM OF MR. JOHNSON.

NO. I. SURFACE SOIL.

Water of absorption	5·25
Organic matter	9·00
Silex	74·80
Peroxide of iron and alumina	5·64
Carbonate of lime	5·24
Magnesia	0·00
	99·89

NO. II. SUBSOIL.

Water of absorption	4·25
Organic matter	6·00
Silex	80·50
Carbonate of lime	4·24
Peroxide of iron and alumina	4·94
Magnesia	trace.
	99·89

In all the four soils, the analyses of which are given above, the grains of quartz from the Calciferous sandstone and the Potsdam sandstone, are accompanied with scales of mica and grains of felspar. We did not search for potash, but it is probably present in a perceptible quantity. The magnesia is much less than in the soils of the Mohawk valley farther east, or in the western soils, while the lime is much greater. It was undoubtedly derived partly from the Primary district, and partly from the shales and limestones of Jefferson and St. Lawrence counties; from the latter of which, also, the lime must have been derived. The primary of the district referred to embraces extensive formations of primary limestone, many boulders of which have been found south of Rome. The granite and gneiss belong to those varieties whose felspar contains potash.

Soils of the Hudson river vallies.

As a general rule, we have found only slight differences in the soils of the Mohawk and Hudson river vallies. The alluvial flats are much the same, and so is the upland soil; but in the last named valley the tertiary clay is more extensive, and it is not unfrequently accompanied with its peculiar sands. In fact, on both sides of the river, from Glen's falls to Kingston on the western side, and Sandyhill to Fishkill on the eastern side, sand, with its clay beneath, is a strong feature in both of these long narrow belts.

Surface soil taken from the first ridge west of Coxsackie.

Just ploughed while in sward.

ANALYSIS.

Water of absorption	4·50
Vegetable matter	5·52
Silex	82·88
Peroxide of iron and alumina	6·04
Carbonate of lime	0·50
Magnesia	0·25
	99·69

The Albany clay, or, as it is in other places called, Post-tertiary clay.

This clay, so far as it is regarded as a soil, may properly be considered in this place. In connexion, we must also speak of the sands which accompany it. The whole may be regarded as one formation. Below it is a stiff blue clay: above, by weathering, this becomes a drab-colored clay, terminating finally in a gray or yellowish sand. The composition of the clay is as follows:

Water of absorption	4·25
Organic matter	1·17
Sulphate of lime	1·00
Silicates	69·02
Peroxide of iron and alumina	17·24
Potash	0.14
Carbonate of lime	4·00
Magnesia	3·00
	99·82

The composition is not constant: the lime varies from four to six per cent, and the magnesia from a trace to the amount given in the above analysis, which may be regarded as the maximum quantity. The analysis by hydrofluoric acid gives a result which does not differ materially from the above. The amount which is credited to the silicates may be regarded as nearly pure silex, as this amount is removed when it is submitted to the action of hydrofluoric acid, which acts upon the silex.

This clay extends into the Mohawk valley, and forms an admirable basis for alluvial flats which border the river. Its composition in Montgomery county gives a result somewhat different from the analysis above. We obtained, for example, from a specimen at Fonda,

Water of absorption and vegetable matter	9·75
Silex	71·92
Peroxide of iron and alumina	14·98
Carbonate of lime	1·75
Magnesia	0·70
	99·10

Potash was not sought for.

It appears from numerous examinations which we have made, that clays contain more or less vegetable matter; they all blacken previous to ignition, and give off the odor of burning vegetables.

A still greater difference of composition exists in the clay-stones of this formation; thus, they contain

Water of absorption	6·28
Organic matter	1·70
Silex	30·88
Peroxide of iron and alumina	9·42
Carbonate of lime	50·98
Magnesia	0·22
	99·48

The clay-stones or concretions may be regarded as recent productions, inasmuch as many appear to be unfinished. They increase in size by accession of matter upon the outside; and as they contain a much larger amount of lime than the adjacent layers of clay, this addition seems to be taken from the particles of lime disseminated through the mass. Their mode of formation is instructive, as it illustrates the manner in which septaria have been formed in the slates and shales of the Erie division of the New-York rocks.

Concretions are not constant in composition; though from the analyses which we find in different authors, the lime is more constant than the other elements. To illustrate this fact, we quote here the analyses of concretions from several localities in Vermont, by Prof. Adams:

COMPONENTS.	DUMMERSTON.	ADDISON.	ALBURGH.
Carbonate of lime	50·08	45·09	53·17
Carbonate of magnesia...	5·40	17·34	2·48
Alumina	28.40	21·13	20·95
Peroxide of iron	8·12	1·73	6·76
Protoxide of manganese..	1·50	0·65	1·50
Silica	8·08	16·18	12·40
Water	.....	.....	3·48

The variation in composition would appear still farther by other analyses: thus, the silex in some of the Vermont concretions amounts to 29·08; the alumina varies from 7·30 to 28·40 per cent; the peroxide of iron, from 1·73 to 8·81 per cent.

Sulphate of lime, which is a common substance in the Albany clay, is not found in the concretions. The largest and most spherical ones seem to be formed where carbonate of lime is in the greatest abundance. In many instances, the same material which forms the claystone, forms, in the clay beds, distinct layers, in some of which silex instead of carbonate of lime is the predominant ingredient. The force which produces a concretion is closely allied to that of crystallization, for there is a tendency to build up regular symmetrical solids. It is active in all semiconsolidated materials, as paste, mortars and clays; and it always begins at a centre, and extends in the direction of the radii of a sphere.

Paring and burning of clay soils.

In this place the question comes up, what changes should clays be made to undergo, in order to become fitted for cultivation? Some maintain that the iron contained in clay is converted by combustion into a peroxide; the former state of the iron being noxious, and the latter congenial to vegetation, or else becoming so by its relations to other elements existing in the soil. Others suppose that it is the sulphuret of iron, existing in clay soil, which is converted into the peroxide by burning; and that the sulphuret of iron is injurious to vegetation. This opinion can not be correct, unless indeed the sulphuret is of that kind which decomposes and forms sulphate of iron, which, in large doses, is unquestionably injurious to plants. We can hardly believe that sulphuret of iron is at all injurious, unless it is undergoing decomposition. Admitting the correctness in part of this view, still the mechanical effect of the burning is far more important than the chemical effect. Clay, as deposited, is close, impervious, or difficult to be penetrated by the roots of plants. Two effects follow from burning: 1st. The soil is rendered open, pervious, and penetrable; 2. Some of the matters in the clay become more soluble. This is maintained by Liebig, who supports his view of the subject by reference to the greater solubility of argillaceous earths in acids after they are ignited, than before. It is true, we believe, however, that the peroxide of iron does exert a salutary influence on vegetation; and this opinion is supported by the character of the productions of a brick red soil. This is certainly found to be a warm soil, there being a perceptible difference in favor of the growth of grass and grain on lands of this color; and it would seem that sheep and cattle are fond of grazing upon these soils, and give them a preference. It appears, then, 1st, that the burning of clays of any kind changes their composition, converting the astringent salts of iron into the peroxide; 2. By ignition, the close texture of the clay becomes open and pervious; 3. Some of the materials contained in clay, or composing it, become more soluble; 4. The color of the clay, which by this process becomes red, absorbs more heat, by which the soil, in common language, is changed from a cold to a warm soil; 5. We may reasonably conclude, that clays, which have been thus treated, become better absorbers of the nutritive gases, as ammonia and carbonic acid.

The operation of paring and burning argillaceous soils can not be followed with injurious effects. Land which is injured by being burned, suffers from the loss of vegetable matter; but they are generally such lands as are cold, or too wet and compact, and require to be drained in order to be cultivated with profit. But to return to the subject of burning clay: Experience has amply proved the benefits of the practice; and it is probable that it is cheaper to treat clay soils in this way, than to attempt to make them porous by the use of sand, which indeed can not impart so many beneficial results as does the method of paring and burning.

Waters from the clay beds.

In this connexion we deem it proper to speak of the composition of the waters which issue from the Tertiary clay, inasmuch as they differ materially from those which are obtained from the general soil of this district. The waters which have been submitted to an examination, were obtained mostly from wells sunk in the clay. The waters of the springs we have noticed possess the same properties as those of the wells, but are sometimes more highly charged with sulphate of magnesia: they all contain large quantities of salts, namely, the sulphates of lime and magnesia, and the chlorides of lime, soda, etc., and sometimes in so great a ratio as to be injurious to the animals which drink of them; but they are not charged with saline matter in the same proportion at all places. Sometimes saline efflorescences cover the exposed banks of the clay in dry weather; at others, large crystals of gypsum are formed in the clay; and usually, where these saline incrustations occur, the water is bitter, and animals, especially sheep, if they drink it, are injured, as it brings on the scouring disease.

The numerous wells in the city of Albany furnish us an opportunity for ascertaining, with sufficient exactness, the amount of saline and other matters contained in the waters issuing from the clay deposit. The first well to which we propose to call the reader's attention, is that in the Capitol Park. It is proper to remark here, that the analyses were all made when the wells were well supplied with water, and that probably the relative amount of solid matter is often greater than what appears in the following results. The water of this well gave the following substances on trial: Chlorine, sulphuric acid, lime, magnesia, soda, silex and alumina. One quart of water contains

Silex	0·12
Vegetable matter (partly crenic and apocrenic acids)	4·57
Carbonate of lime	3·62
Magnesia	0·87
Peroxide of iron and alumina	0·74
Chloride of sodium	
Sulphate of lime	

Water of the well at the Old State House in State-street.

Solid matter in one quart, 9 grs.

Silex	0·50
Alumina	0·15
Organic matter	3·00
Carbonate of lime	2·37
Chlorides and sulphates	3·98

Well at the Exchange.

One gallon contains 65·17 grs. of solid matter.

Silex	0·12
Alumina	0·50
Lime	7·24
Organic matter	4·27
Sulphate of lime	3·75
Chloride of sodium and magnesium	49·29

In the course of evaporating the waters, it was not unusual for them to give off odors which showed rather too plainly that they contained a disagreeable quanity of animal matters in solution. In one instance the room and adjacent hall were filled with the odor common to stables, and yet this water is in constant use both for cooking and drinking.

Another well is quite remarkable for the amount of solid matter contained in its waters. We obtained from one gallon 245·76 grains of solid matter, after a large amount of ferruginous matter had separated in the form of a precipitate. It consisted of protoxide of iron and carbonate of lime : a trace of magnesia and the sulphates, only, was detected in the water.

It is evident from the numerous analyses which have been made of the waters of the Tertiary or Albany clay, that these waters are not only hard, but frequently are so highly charged with mineral substances as to be unfit for domestic purposes. Another object for which they are not at all adapted, is for the generation of steam for moving machinery : it has been found in practice that they can not be employed for this purpose, as the boiler is rapidly destroyed under their use.

The springs which issue from the upper part of this formation, are much better adapted to the purposes of life. The water of the Patroon's creek contains only 3·12 grains of saline matter per gallon ; in addition to this, 1·60 of organic matter was found, making the solid contents in a gallon only 4·72 grains. A little distance below, the water used for a large manufacturing establishment gave 4·48 grains of solid matter, and of vegetable matter the same as before. The soluble matters consist of chloride of lime, magnesia, sulphate and carbonate of lime: probably the latter exists in a state of a crenate.

The water of the Hudson river contains 4·48 grains of soluble matter per gallon; the amount of vegetable or organic matter is 1·84, in which it was evident some animal matter existed, as, on ignition, it gave a perceptible odor of burning hair: the whole amount is then 6·32 grains per gallon. Another specimen gave 7·24 solid matter, of which 3·34 grains consisted of organic matter. The waters of the Mohawk river gave 5·36 grains to the gallon, of which 2·52 was organic matter.

The following is a summary of the results of several analyses of waters of the clay, together with penstock water of the city.

The penstock water of the city contains, of		
Soluble matter, per gallon	4·64	
Organic matter	8·00 =	12·64
A well in Lydius-street,		
Soluble matter	13·12	
Organic matter	6·12 =	19·24
The well at the Old State House,		
Soluble matter	24·00	
Organic matter	12·00 =	36·00
The well at the Exchange,		
Soluble matter	47·20	
Organic matter	17·48 =	64·68
The well of the Capitol Park,		
Soluble matter	47·24	
Organic matter	18·28 =	65·52

A well at the corner of Lydius and Union-streets gave 112 grs. to the gallon: it consisted mainly of iron combined with an organic salt (crenate of iron). It gave a bulky greenish precipitate with acetate of copper. The water, on standing an hour, becomes turbid and yellowish, and, finally, in the course of three or four hours, deposits a large ochreous sediment. Horses and cattle are quite fond of this water, and drink it freely.

Another kind of water of the Albany clay is quite common in the valley of Lake Champlain. It abounds with the sulphates, particularly the sulphate of magnesia, and is so excessively bitter that it can not be drank. It is used somewhat in cutaneous eruptions, but is far too saline to be used to any great extent even as a medicinal water, inasmuch as it is nearly impossible to drink it. The mineral springs which are pleasant, and so extensively used, belong to the Hudson and Champlain district; but none of these waters issue from the clay. They either belong to the slate or the lower limestones, and consist mainly of chloride of sodium and the bicarbonates of magnesia, soda and lime. These waters differ from the preceding, also, in containing iodine and bromine. We regard it as a remarkable fact that the celebrated Saratoga waters belong chiefly to the Calciferous sandstone, though at Ballston the same kind of water issues from the Hudson-river slate.

The lower part of the Champlain division furnishes a few sulphur (or, as they are sometimes called, Harrowgate) springs, of some interest. The most important known to me, and which I have examined, are in the town of Massena, St. Lawrence county. At this place, there are three within a few rods of each other. They issue from the Calciferous sandstone, immediately upon the north bank of the Racket river, about three miles from the St. Lawrence, and just above the Long Sault. The temperature of one was found to be 46° ; another, 48° ; and the third 52°, the thermometer standing at 82° in the shade. These springs are within thirty feet of each other. All these springs possess nearly the same taste, and deposit a whitish incrustation upon the stones over which the waters flow. The quantity of sulphuretted hydrogen is considerable, as it may be perceived by its odor a mile from the locality.

The waters whose temperature stands at 46° and 52°, are composed as follows :

	WARM SPRING.	COLD SPRING.
Chloride of sodium	6·988	6·202
Chloride of magnesium	0·644	0·846
Chloride of calcium	1·026	0·466
Sulphate of lime	2·794	1·960
Carbonate of lime	1·630	1·200
Hydrosulphuret of soda, magnesium and vegetable matter	0·000	1·870
Solid matter in one pint	13·082	12·544

The water of the warm spring had lost its gas entirely, as it did not blacken silver ; the other retained a portion, and both contained vegetable matter, which seemed to be combined in some way with the sulphuretted hydrogen. Without doubt the gas is produced by the decomposition of the sulphates, by the vegetable matter of the water. In another place, I shall offer a few remarks on the origin of the mineral springs of the State.

The sulphuretted hydrogen springs which belong geologically to the Taconic slates, as well as to the slates of the Hudson river, appear to be less charged with saline matter than is usual with such springs. I have examined a small spring of this character, issuing from the slates forming the crest of the ridge on the east bank of the Hudson, about four miles from Albany, and obtained the following results :

One pint gave 8 grs. solid matter, consisting of

Chloride of sodium	1·042
Sulphate of lime	1·816
Sulphate of magnesia	4·116
Carbonate of lime	0·620
	7·594
Hydrosulphuret of magnesium and organic matter,	0·406
	8·000

The quantity of gas remains undetermined, and it is assumed that the combination is as I have here stated. A small quantity of sulphur is deposited upon the stones and other substances over which the water flows.

The large bodies of water which are collected in reservoirs formed in the rocks belonging to the Champlain division, are generally soft, and quite free from mineral and organic matter. We have an illustration of this fact in the water of Lake Champlain. It gives only a faint cloud with nitrate of silver, and scarcely a perceptible precipitate with chloride of barium; hence there is almost a total absence of the chlorides and sulphates, bodies which most usually exist in hard or mineral waters. This is accounted for by the purity of the waters which supply the lake. Most of the rivers and streams rise either in the Primary region, or in the hard shales of the Primary and Taconic system of Vermont. The drains from the Tertiary clay upon its border scarcely affect the great mass of the water forming the body of the lake.

A SERIES OF TABLES,

SHOWING THE MOST IMPORTANT FACTS IN METEOROLOGY, SO FAR AS THE HUDSON AND MOHAWK DISTRICTS ARE CONCERNED.

TABLE I. *Showing the mean temperature of each month in the year.*

LOCALITIES.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual mean.	Highest and lowest temp.		Annual range.	Greatest monthly range.
Albany	26·61	24·73	39·46	47·30	59·21	69·51	73·83	74·08	61·03	53·28	43·27	22·67	49·58	97	—11	108	63
Gouverneur,	10·52	16·10	33·78	43·07	48·88	67·44	73·33	71·88	57·19	51·71	37·30	14·22	43·87	99	—30	129	82
Lowville ..	22·97	23·53	34·63	43·10	39·67	47·85	50·56	50·83	65·66	46·50	34·28	17·02	39·72	92	—27	119	82
Potsdam ...	19·82	22·02	35·30	43·30	53·70	65·64	67·25	70·39	56·41	49·47	35·60	15·39	44·52	94	—20	114	70

TABLE II. *Prevailing winds of each month.* 1845.

LOCALITIES.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Albany	NW	NW	S	S	S	S	NW	S	S	S	S	S
Gouverneur ..	N	N	N	N & S	S	SW	S	S	W	W	S	N
Lowville	S	S	S	SE	SW	S & NW	S	N	S	W	S	N
Potsdam	NE	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW

TABLE III. *Annual Results.* (No. of days.)

LOCALITIES.	N.	NE.	E.	SE.	S.	SW.	W.	NW.
Albany	61	17½	14½	7	134	8½	12	110½
Gouverneur ..	103	16½	4	6	89	66½	53	27
Lowville	67½	2½	4	42½	106	17	40	85½
Potsdam	16	54	3½	18	36½	149	38	50

TABLE IV. *Showing the quantity of rain for ten years, from* 1826 *to* 1835 *both inclusive, so far as reported, with a general mean for those years.*

Total fall of rain and snow in each year.

LOCALITIES.	1826.	1827.	1828.	1829.	1830.	1831.	1832.	1833.	1834.	1835.	General mean.
Albany	33·12	49·80	37·66	38·07	41·85	39·52	44·45	41·74	32·35	40·44	39·91
Gouverneur ..	.....	.....	.....	.....	.....	.....	.....	33·80	26·66	46·16	35·54
Lowville	.....	32·87	38·42	28·07	36·66	39·79	29·12	35·08	.....	39·12	34·52
Potsdam	.....	.....	35·67	27·79	.....	30·36	22·11	39·27	25·20	29·68	30·00

TABLE V. *Comparative view of the quantity of rain for each of the last ten years, so far as reported, with a general mean for the whole number of those years.*

LOCALITIES.	1836.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	General mean.
Albany	44·60	41·17	42·03	38·11	44·38	37·85	45·99	48·35	35·00	39·45	41·69
Gouverneur ..	26·70	.....	20·02	19·63	.....	22·77	18·94	.....	25·46	33·48	23·85
Lowville	.....	.....	.....	28·40	39·99	28·86	34·53	27·16	26·47	30·69	30·87
Potsdam	18·54	23·58	26·78	22·96	32·48	20·77	28·53	34·14	31·67	31·02	27·05

TABLE VI. *Amount of rain and melted snow, observed at the Albany Academy, compiled from its Meteorological Register, by* Prof. Ten Eyck.

The figures indicate the depth in inches and decimals of an inch.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1826	2·43	1·36	3·81	1·77	0·76	6·22	5·53	2·46	3·58	2·37	1·56	1·27
1827	5·40	3·07	2·38	4·66	3·43	3·75	5·43	4·69	5·67	4·65	2·76	3·91
1828	2·25	2·53	1·94	2·52	4·48	2·87	5·40	0·88	8·08	1·56	4·91	0·24
1829	4·56	3·26	2·78	4·77	2·68	3·90	3·22	1·46	2·73	2·41	3·86	2·44
1830	1·76	1·41	4·86	2·37	4·63	7·58	2·37	1·55	0·93	3·15	7·29	3·95
1831	1·88	4·17	2·38	4·59	2·88	4·04	4·32	3·25	3·93	4·82	1·71	1·57
1832	4·21	3·12	2·59	2·90	2·69	3·57	4·28	7·51	2·76	4·20	3·28	3·34
1833	2·63	2·56	1·62	1·33	8·47	2·36	4·48	3·36	3·14	7·50	2·43	1·86
1834	1·35	2·04	1·60	2·35	3·70	2·32	5·25	2·77	2·34	3·77	1·37	3·59
1835	4·64	1·79	2·60	4·54	2·71	6·48	5·39	5·34	1·28	2·22	2·26	1·19
1836	7·30	4·39	1·70	2·30	3·86	5·67	2·43	2·25	3·49	3·99	3·31	3·91
1837	2·25	2·77	3·47	1·63	7·34	5·06	4·38	3·96	1·95	3·59	2·14	0·63
1838	2·25	2·20	2·09	1·53	7·45	7·60	1·72	4·91	4·46	3·32	3·55	0·95
1839	2·17	1·57	1·52	4·75	3·83	5·12	5·77	1·24	2·75	1·35	2·95	5·09
1840	2·16	2·44	3·99	5·23	2·28	3·47	3·40	4·77	5·76	4·81	3·13	2·95
1841	4·19	2·12	3·15	3·75	2·24	2·10	1·56	4·27	5·65	1·34	3·34	4·14
1842	1·15	3·21	2·69	4·90	1·44	4·44	3·42	4·15	6·40	4·22	4·76	5·21
1843	2·13	3·21	7·37	4·25	2·07	5·54	4·42	6·05	2·19	5·72	3·04	2·36
1844	1·35	2·04	1·60	2·35	3·70	2·32	5·25	2·77	2·34	3·77	9·37	3·59
1845	4·64	1·79	2·60	4·54	2·71	6·48	5·39	5·34	1·28	2·22	2·26	1·19
1846	3·03	3·72	3·34	0·74								

Greatest quantity of rain in any one month, for 20 years, May, 1833; smallest ditto, December, 1828.

TABLE VII. *General Summary.*

PLACES.	Mean temperature.	Prevailing winds.	Av. quantity of rain.
Albany	20 years, 48·26	20 years, S	20 years, 40·80
Lowville	17 " 43·61	16 " NW	15 " 32·82
Gouverneur ..	13 " 43·66	13 " SW	
Potsdam	18 " 43·35	19 " SW	17 " 28·26

4. WESTERN, OR WHEAT DISTRICT.

It is not without reason that the central and western counties of New-York are called wheat-bearing counties, by way of preëminence for their adaptation to this crop. Probably there is not another so good a district for wheat in this country; and this is true, whether we take into account the amount which may be raised per acre, or the quality of the grain itself. It is true too that the average product is far less than many premium crops which are raised elsewhere; still, we believe that no country can produce larger, if the growers of wheat in this district were disposed to work for a heavy crop. The truth is, what is produced may be regarded rather as the spontaneous growth of the fields, than one which is produced by high cultivation.

There is another point of excellence possessed by the lands of this district, which has been too little respected: it is the durability of the lands, or the ability with which they stand cropping. This does not arise from a deep vegetable mould, an accumulation of organic matter in the soil, the product of time and of the waste of materials once organized, and now going back to the inorganic state; but it is due rather to the energies of the soil itself, and derived from its inorganic constituents. But even here there is no want of these semi-organized matters, so important to a grain-producing country.

We have spoken of the high character of the western and middle counties of New-York, for growing wheat. We are not able, however, to strike out the boundaries of the wheat region in undeviating lines. We consider that it properly begins near the head waters of the Mohawk, from which a line drawn to Lake Ontario near Oswego, and then along the lake to Niagara river, will mark its northern boundary. The southern boundary we have drawn east and west through the middle of Cayuga and Seneca lakes. So far as the vallies are taken into account, the wheat-growing country extends much farther; but if the high lands of the Hamilton group of rocks are regarded, it may not extend so far. We find in this, as in many other cases, that it is difficult to define lines of demarkation; that there is no such thing in nature as a straight barrier or limit where this grain ceases to be a valuable crop, or could not be rendered so under a proper system of cultivation; that is, wheat will grow and reproduce itself, at least in a moderate crop, over the whole of the southern tier of counties. Yet when we examine Onondaga, Orleans and Livingston counties, we can not overlook the fact that there is something here which favors the growth of this grain, which does not exist on the Allegany and Chemung hills.

An interesting inquiry may be started here, namely, to what cause or causes is it to be attributed, that this district is so well adapted to wheat, or what makes it superior to those lying adjacent to it? Some differences of opinion prevail on this question. There are some who say that the belt of limestones, which passes through this district, gives it the wheat-growing property; and it has been attempted to prove, by the statistics of this crop, that the limestone counties exceed in productiveness those which are not based upon this rock. There is, it is true, some show of truth in this view of the question; nevertheless, the view is fallacious, and has but a small foundation to support it. Calcareous matter is an important element in a wheat soil; but this is not all, and even if it were so, the Onondaga limestone would fail to furnish the amount required to fertilize this large district. Now in looking about us for the solution of this question, we find that the true elements of the wheat soil exist mainly in the shales associated with the limestones, particularly those of the Onondaga-salt group. In addition to these, the rocks of this group, the gray and red marl of the Medina sandstone, and the shales and slates of the Ontario division, exert an important influence on the soil, which bears favorably upon the growth of wheat. In support of this view, we may observe that the Onondaga and Niagara limsetones are but slowly converted into soil; they are too hard and compact to be reduced to the condition required: hence, we regard them as performing an inferior part or office in this matter. The cause is truly geological; but the part these comparatively pure limestones perform, is quite subordinate to that of the shales and marls. This is necessarily true, from the feeble action of the weather and other decomposing agents on these rocks, as well as the nature of the product which is produced by these causes. The debris of the pure limestones does not favor the growth of the crop with the same power and permanence as the debris of the shales, neither mechanically nor by composition.

The rocks which have been just referred to as those which give to this district its distinctive crops, extend from the base of the Ontario division, the Medina sandstone, to the Onondaga limestone, the upper rock of the Helderberg division. By reference to what has been already said of the lower members of this last division, it will be seen that they are largely developed in the district under consideration, but it is known that they do not extend to the limits of this district on the south. There is no difficulty on this point, so long as it is plain that the debris of the fragile and easily decomposing masses are found far south. To the transportation of this debris of the shale, must be attributed the extension of the wheat district beyond the limits of the rocks which give origin to it. They have been used abundantly for this purpose, and their nature aids materially this process; while the hardness of the limestone, and its small depth compared with the shales, disqualify it to perform the office assigned it. An inspection of the materials proves the position we have taken. A perceptible quantity of the peculiar debris of the shales can always be discovered in the wheat soil, and may be known by the peculiar color which it imparts to the soil.

An inspection of the nature and composition of the soil explains to us the reason why this district is more productive in wheat than those adjacent to it. Where the soil is thin, but reposes upon the shales of the Salt group, additional matter is added to the former soil, by the rapid decomposition of the rocks at or near the surface; and where we detect, by ocular inspection, the small angular masses of the shaly limestones of the gypseous rocks, or find a soil of the peculiar drab color of those of Onondaga and Livingston counties, we may be satisfied that it will produce wheat, and that this is its natural crop.

The wheat district, as we have bounded it, extends from the south shore of Lake Ontario, to a line drawn through the middle of Cayuga and Seneca lakes. It is not claimed that the whole of this district is better adapted for wheat than for any other kind of grain; for on the south shore of Cayuga lake, much sandy soil is found, which is not well suited to wheat, but is better for rye. This soil seems to be derived from the sandy parts of the Medina sandstone, the strata of which are often well developed, and differ greatly from the marly part of the rock noticed in the foregoing pages.

The composition of the soil of this district is illustrated by the composition of the rocks from which it is derived. We shall therefore give several analyses of the most important, those especially of the softer kinds, which furnish the greatest amount of material. The first which we shall notice, and which seems to be the most liable to disintegration, is the red shale, the lowest member of the Onondaga-salt group. Two varieties have been noticed; the sandy and the marly, or the soft red shale quite destitute of grittiness, and which is often spotted green.

ANALYSIS.

	SANDY.	MARLY.
Silex	68·25	68·86
Peroxide of iron and alumina	6·25	14·98
Magnesia	5·75	0·40
Carbonate of lime	10·25	9·89
Phosphate of alumina, and phosphate of peroxide of iron	0·00	0·14
Water	1·00	6·48
	99·50	99.25

The sandy variety was taken from the horizontal rock at Canastota, which is now penetrated for a brine spring, and furnishes a tolerable amount of water.

The most important fact brought out in the analysis of the rock, is its calcareous matter. Magnesia also is a constant element, but probably varies in amount at different places. The marly variety forms by far the greatest proportion of the rock, and hence may be considered as the part which gives character to the soil. Observation confirms the view which we should form of the character of the soil derived from this rock. It is well adapted to the wheat crop, and is slowly exhausted by cultivation. It is sometimes employed to renovate soils which are partially worn out.

The rock which succeeds the red shale, is a soft greenish marl, whose composition continually varies by the presence of bands of gypsum. The red color disappears, while the soft shaly nature of the rock continues: it therefore forms a soil quite similar to the preceding. This mass may be known, however, not only by its green color, but by the presence of cavities in the form of the hollow cubical crystals of salt, or chloride of sodium.

The composition of this rock is as follows:

Water of absorption	0·56
Organic matter	5·00
Silex	34·56
Carbonate of lime	43·06
Alumina and protoxide of iron	13·36
Sulphate of lime	1·06
Magnesia	2·17
	99·71

The red and green marly rock, when submitted to the action of cold water, furnishes a quantity of soluble matter. Thus from 100 grains, we obtained of

	RED MARL.	GREEN MARL.
Soluble matter	1·25	3·50
Organic matter or acids	0·57	0·87
Saline or bases	0·68	2·63

The thin beds of green shale are subject to decomposition, and the debris remains on the dry shelving rocks in the form of gray bitter powders, consisting mostly of the sulphates of soda and magnesia, mixed also in varying proportions with the chlorides of sodium, magnesium and calcium, and the sulphate of lime and sometimes alumina. One hundred grains of the most earthy powder yielded of

Soluble matter	6·53
Organic matter	1·03
Saline matter	5·50

The latter consists of the above enumerated elements. In many instances the saline matter may be collected in a pure condition, or nearly free from earthy matter. This fact explains the cause of the constant fertility of the soils derived from these rocks: the amount of saline matter which they furnish is always sufficient to supply the wants of vegetation. The analysis of the shales gave another important fact, namely, that the organic salts exist in them ready formed.

Vegetable materials may be recognized always when they are ignited, both by their blackening, and by the peaty odor which they exhale when subjected to the action of heat. This organic matter must have been derived from vegetables which belonged to the period when the rocks were being deposited. It also increases the fertility of the soil; and as it is furnished in proportion to the disintegration of the rock, it can rarely happen that the soil will be exhausted of its organic matter by a judicious course of husbandry.

The condition of the organic matter is much the same as that which exists in ready formed soils: crenic and apocrenic acids constitute the greater part of it. These are combined with the alkalies and alkaline earths, which, when they have been ignited, are decomposed, and pass to the condition of carbonates. Hence it is that we obtain carbonates in all our analyses, where rocks or soils have been subjected to a red heat. The carbonates therefore do not exist originally in the organic matter, but are a result brought about by the processes to which they have been subjected.

The rocks under consideration are usually concealed by a great amount of their own debris. It is therefore impossible to determine their thickness or their extent; they are, however, between one hundred and fifty and two hundred feet thick.

We have already stated that the shales contain beds of gypsum. The lowest beds are merely thin inconsiderable masses, unfit or unprofitable for working; yet the amount of plaster is considerable. The rock itself, with its plaster, would form a very valuable manure in many parts of the State. The decomposing shales, when plaster is wanting, may be regarded as valuable as gypsum, and perhaps more so; they have not, however, been employed, and hence have not received the sanction of experiment or trial.

In addition to the plaster beds, the shales embrace a singular deposit, which was called by Mr. Eaton *vermicular limerock*. This deposit, however, is not entitled to a distinct name, inasmuch as it is subordinate to the shales, and forms but an inconsiderable mass in the group. The vermicular rock is an impure limestone, and is composed of the following elements:

Water	0·23
Organic matter	2·54
Silex	3·30
Carbonic acid	20·62
Alumina	5·33
Magnesia	4·26
Carbonate of lime	13·76
Protoxide of iron	a trace.
	50·04 in 50 parts.

The main deposit of plaster is above those porous strata, the composition of which has been furnished in the preceding pages.

The soft green shales pass into thin-bedded limestones, quite compact and hard, and which, on being struck, emit a sharp ringing sound similar to clinkstone. These thin beds contain the hydraulic limestones, which have been described.

These parts of the series differ considerably in composition from those below. According to Dr. Beck, their composition (the water-limes) is as follows:

Carbonic acid	39·80
Lime	25·24
Magnesia	18·80
Silica and alumina	13·50
Peroxide of iron	1·25
Moisture and loss	1·41
	100·00

The above analysis represents the composition of the western hydraulic limestone. The same series exist, however, in Ulster county. Their analysis was made by Dr. Jackson, and gave the following result:

Water	1·182
Silicic acid	10·087
Carbonic acid	41·200
Sulphuric acid	0·606
Lime	25·087
Alumina	3·395
Peroxide of iron	3·274
Magnesia	12·890
Oxide of manganese	0·606
Potash	0·700
Soda	2·182
	100·000

One hundred grains of the powdered rock give one grain of soluble matter; of which there remains after ignition, 0·56 of a grain, leaving 0·44 for vegetable matter principally.*

From the several analyses, it will be observed that magnesia is an important and constant constituent of the shales and hydraulic limestones. The superior rocks contain a larger proportion than the inferior or gypseous deposits. There is no doubt this element exerts a beneficial influence on the crops, especially maize and the cereals. The question has been agitated whether magnesian rocks were favorable to vegetation. It seems to be set at rest by observation in New York, where magnesian rocks are so prevalent. No part of the State is more fertile than those underlaid with the magnesian rocks. The same view is supported by observations in Berkshire (Mass.), where the dolomites prevail. Here the most fertile lands are underlaid by magnesian deposits. When, however, a magnesian limestone is burnt and converted into a caustic condition, the magnesia remains a long time, and if used before it is nearly saturated with carbonic acid and water, it injures vegetation; but when slacked, it is equally harmless with the air-slacked lime. Without doubt it is an advantage to use the two alkaline earths together, if proper precautions are observed; for magnesia seems to be as essential to the composition of many grains as lime, and may undoubtedly replace it when the lime is wanting.

In the western counties, we pass from the Hydraulic or Magnesian limestones to the Onondaga limestone: the reason of this has been already explained. This limestone is a hard gray crystalline rock below, but passes upward into a dark shaly cherty rock, which is usually described under the name of *Corniferous limestone*. It extends from the Hudson river to Blackrock on Lake Erie, forming a belt from three to six miles wide.

* Jackson's analysis of the Ulster county cement stone, in the Proceedings of the American Geologists and Naturalists.

The influence of this rock upon vegetation is much less than that of the preceding. There is not only a change in the constitution of the limestone, but it is quite different in its texture. Magnesia is no longer an essential element, and the rock has become hard and little subject to disintegration. It is nearly a pure limestone, and the soils upon it are drier, and perhaps more friable; but they do not retain so firmly the roots of wheat, and hence the crop is more liable to injury from late frosts. Many wide fissures exist in this rock, through which the surface water passes, and hence there is often a deficiency.

The Onondaga limestone may be regarded as a pure calcareous rock, or as pure as chalk and most limestones which are employed for quicklime.

ANALYSIS OF FIFTY PARTS.

Hygrometric water	0·46
Organic matter	0·50
Silex	1·87
Alumina and protoxide of iron	0·09
Phosphate of lime	0·03
Carbonate of lime	44·50
Carbonate of magnesia	2·00
	49·39

Composition of the soils of the wheat district.

The first analysis given below, is of a soil of the red shale near Canastota, and which was derived mainly from it. Its composition may be compared with that of the rock from which it is derived.

ANALYSIS — ONE HUNDRED GRAINS.

Water of absorption	1·50
Organic matter	2·50
Silex	85·00
Peroxide of iron and alumina	8·12
Carbonate of lime	2·17
Magnesia	0·12
Phosphate of alumina	0·50
	99·91

There is a loss of lime and magnesia in the process of disintegration.

A practical suggestion of some importance grows out of these analyses, viz. that it would be profitable to spread the decomposing shales over the soils wherever they are accessible. The lime and magnesia might be supplied at a cheap rate. The advantage arising from this procedure consists in supplying lime in a finely divided state. Where wood is plenty, the condition of the materials would be improved by burning: a larger amount would become soluble by the process.

We may now stop and consider for one moment the state and condition of the particles which compose the rocks whose analyses we have just given. From the Niagara limestone, upon which the red shale and marl repose, up to the Oriskany sandstone, the materials are all extremely fine, excepting a thin sandy band near the top of the red slate. For seven or eight hundred feet, then, the rocks which form a large body of soil are in that condition as it regards size, which fits them for the most effectual action of the roots of plants, and for the solution so necessary to prepare them to be received into the texture of the plant. The fineness is not such as to pass readily into an impalpable state; such, for instance, as is at all liable to pack, and thereby exclude air and moisture. We regard the condition we have here described as quite desirable for wheat, and all other crops which admit of high cultivation.

The origin of the materials constituting these shaly rocks can not be determined with certainty. That they were not the immediate result of abrasion from primary rocks is certain, inasmuch as their fineness could not have been effected by such an operation, unless indeed the materials should be regarded as having been transported far from their parent rock; and, besides, we are unable to detect, by a common microscope, any grains of felspar or mica, or the products of any primary rocks, except fine rounded grains of quartz. A fact which bears upon the question under consideration, is, that no fossils are known in the red and green shales, those deposits which are so exceedingly fine; and this fact seems to favor the view that the deposition actually took place in a deep sea, at a depth at which organic beings are not known to exist.

The rock, which succeeds the Onondaga limestone, is the Marcellus slate; and it is so closely related to the shales below, that its composition may be given in this place. The rock is of course thin-bedded and liable to disintegration, and is therefore usually concealed at its outcrop. It is calcareous in many places, and at some points it appears that an unusual quantity of lime was deposited with the slate, as a large quantity of septaria is inclosed between the layers at such places; at other places, thin bands of limestone appear.

The shales, in their most common condition, are composed of the following substances:

Water of absorption	2·00
Organic matter	2·25
Silex	48·12
Peroxide of iron and alumina	10·00
Carbonate of lime	36·60
Magnesia	1·00
	100·07

The vegetable or organic matter is quite as abundant as in the green shales, but it is more carbonaceous, or charred, and hence the dark color under which the rock usually appears. Sometimes, however, the dark color is due to the presence of decomposing pyrites.

The passage from the Marcellus shales to the Hamilton group is easy, and is effected by an increase of siliceous matter in a coarser state; besides this change, we may often detect mica in the rock. The condition of the Hamilton group enables it to resist the action of the weather, and hence it is common for it to appear in mural precipices or in well exposed outcrops. A more important change, however, remains to be noticed; it is the disappearance of lime and magnesia, or rather a very perceptible diminution of both. It is not supposed that any rock is entirely destitute of either of these elements, yet it is not uncommon that it is diminished so far as to influence the growth of the cereals, as well as of maize. The consideration of the Hamilton group will be deferred for the present.

The soil derived from the red shale may be distinguished from the succeeding green shales by its red color. Where it is unmixed, and consists wholly of the matter of the rock, it is frequently a heavy tenacious clay; and usually it has more tenacity, and is more compact than the soils from the rocks below or above. Its composition indicates the relation it bears to the wheat culture, and the confidence which may be placed in it as to returns for many years in succession. It furnishes the phosphates of alumina and iron, and the carbonates of lime and magnesia. We have already hinted that it may be improved by employing the broken down rock; a plan, which, if systematically pursued, would forever prevent its deterioration. This opinion is justified by experience in a few instances.

Soil of the green shales.

We notice this product of the rocks next succeeding in the ascending order, though its characters, when its components are taken into consideration, are much the same as the soil of the red shale. Its color, however, is quite different, and it is less compact; and these shales, we believe, never produce a stiff clay, but the soil has a good body, and can never be ranked among the light soils. The standard specimen of this soil yields, on analysis,

Water of absorption	5·16
Silex	35·54
Carbonate of lime	2·50
Magnesia	1·50
Sulphate of lime	0·50
Peroxide of iron and alumina	4·87
Phosphate of alumina	0·06
	50·13

Two hundred grains, submitted to the action of cold water for a few days, gave, of

Soluble matter	1·34
Organic matter	1·00
Saline matter	0·34

Another specimen, from the vicinity of the Green lakes near Manlius centre in Onondaga county, gave

Soluble matter	2·00
Organic matter	0.44
Saline matter	1·56

The matter which is set down as organic, consists mainly of crenic acid. It is in combination with the alkalies and alkaline earths, potash, lime and magnesia. In the same products, alumina or phosphate of alumina is invariably present. The clear solution is always disturbed by caustic ammonia; a light flocculent precipitate appearing soon after the addition of the ammonia. Chloride of sodium is another substance present in the solution, and we also obtain sulphate of lime. It may appear to some that the quantity of these compounds is too small to exert much influence on vegetation. When, however, the whole quantity contained in an acre, not exceeding the depth of one foot, is estimated, it will be found that it exceeds, or at least equals the manure which the best farmers ever use upon their lands. The amount of soluble matter in a good soil is not less than twenty tons per acre in the depth we have indicated; but this is only about one-fifth the quantity which actually exists, and which, in process of time, will be converted into the food of plants.

The soluble matter which we obtained from two hundred grains taken from a field of G. Geddes, Esq. of Fairmount, and upon which barn-yard manure has not been spread for twenty-five years, was

Soluble matter	1·47
Organic matter	1·18
Saline matter	0·29

In this, as well as in other trials, the organic matter is crenic acid in combination with lime and magnesia. The condition in which the saline matter is obtained, is that of a carbonate, which is formed in the process of incineration.

Another soil, which had never been ploughed, gave

Soluble matter	1·34
Organic matter	0·34
Saline matter	1·00

Treated in the usual way of analysis, the cultivated and uncultivated soils gave

	CULTIVATED.	UNCULTIVATED
Water of absorption	5·25	4·79
Organic matter	6·67	5·24
Silicates	77·50	78·25
Peroxide of iron and alumina	7·75	8·27
Carbonate of lime	1·25	1·15
Magnesia	1·10	1·20
Sulphate of lime	0·22	0·20
	98·80	99·16

The green shales, or rock from which the above soils were derived, is composed as follows:

Water of absorption	0·50
Organic matter	6·00
Silicates	34·56
Carbonate of lime	50·06
Carbonate of magnesia	2.16
Peroxide of iron and alumina	6·38
	99·66

The inorganic salts, the sulphates of lime and magnesia, and chloride of sodium, exist also in the rock, but the proportion was not determined.

The composition of the rock is eminently fitted to sustain a soil in constant fertility. The upper surface of the rock, when near the top of the ground, is easily broken up by the plow; and its debris, being mixed with the old soil, becomes speedily a fit material for sustaining a vigorous growth of the cultivated vegetables.

It is a fact worthy of a passing notice, that although gypsum abounds in the midst of the shales which underlie Onondaga and Cayuga counties, still it is not only wanting in the soil as a general rule, but is required in the practice of husbandry, and seems to produce effects as beneficial as in any other part of the country where it is unknown among the formations. This may arise partly from its solubility: it may be removed rapidly from the soil by solution. If this is true, it is evident that there is no danger to be apprehended from an accumulation of it in the soil by the ordinary use of it. Another reason why plaster is not found abundantly in the soil, is its change of constitution, or its change from a sulphate of lime to a carbonate, by means of the carbonate of ammonia contained in the atmosphere. This change seems to be indicated by a few experiments which have been made during the last five years.

The debris about the beds of plaster consists mainly of carbonate of lime, largely mixed with clay in which it would seem that sulphate of lime must have existed originally. Thus the debris of the plaster beds from Cayuga bridge, I found composed as follows:

Water of absorption	4·88
Organic matter	3·00
Silicates	41·75
Peroxide of iron and alumina	8·88
Carbonate of lime	22·20
Carbonate of magnesia	19·30
	100·01

As the debris about these beds is often rich in magnesia and carbonate of lime in a state of minute division, there is no doubt but the material will be as useful, applied to land, as the plaster itself; besides, it is not necessary that it should be transported to a plaster mill, as it undergoes disintegration, and becomes in a few years sufficiently fine for use.

A soil taken from the forest near the Green lakes in Manlius, gave, on analysis,

Water	4·00
Organic matter	6·25
Silex or silicates	77·00
Peroxide of iron and alumina	9·74
Carbonate of lime	3·00
Magnesia	0·50
	100·49

In this analysis, I obtained a greater percentage of carbonate of lime than usual; and it appears highly probable, from this analysis, and from the circumstances of the case, that a part of the sulphate of lime of the green shales may be converted into a carbonate in the soil, and perhaps a part is carried away in solution. This latter supposition appears quite probable in this case, as the water of the Green lakes, which receive the wash of the surrounding hills, contains much gypsum in solution.

A soil taken from the flats near Manlius centre, and which has been long under cultivation, gave

Water of absorption	4·00
Organic matter	8·50
Silex	79·54
Peroxide of iron and alumina	6·49
Carbonate of lime	1·41
Carbonate of magnesia	trace.
	99·94

This soil has been long famous for its wheat crops; and although it does not afford a very large return, yet it has been cultivated for this grain for twenty-five or thirty years past.

The most important fact brought out in many of the analyses of the soils of this district, does not indicate deterioration, much less an approach to barrenness. Even intances occur, where the cultivated soil seems to be richer than the new and uncultivated; and such a view is not very improbable, inasmuch as the soil in many instances is renewed, or rather has new matter from the rock added to it. This takes place only when the soil is ploughed; for the rock beneath is defended by a coat of earth, and its disintegration is promoted only when its surface is partially exposed by the common operations required in tilling the soil.

Cayuga county contains large tracts of soil adapted to wheat. Those which are most esteemed, and upon which this crop rarely fails, are clay bottoms, upon which the surface never heaves, or the grain very rarely winter-kills. This property of clay, that of holding the roots when the surface is frozen, is highly important.

The following is an analysis of the clay which appears at many points along the shore of Cayuga lake, and which may be regarded as the subsoil of the county.

Organic matter and water	14·36
Silicates	48·12
Peroxide of iron and alumina	24·00
Carbonate of lime	12·00
Magnesia	1·00
	99·48

Three or four hundred feet above Cayuga lake the soil is looser, and though rich and productive in all crops, and in wheat if the season is not adverse, is considered, however, less favorable for the crop, as it is more liable to be heaved out by frost than the clay soil.

The following is an analysis of the soil which forms the ridge at Great Fields, near the residence of David Thomas:

Water of absorption	4·40
Organic matter	10·24
Silicates	73·12
Peroxide of iron and alumina	12·06
Carbonate of lime	0·40
Magnesia	0·12
	100·34

A soil, forming the sides of the ravines, and in which the *Kalmia latifolia* thrives, gave the following results on analysis:

Water of absorption	2·92
Organic matter	6·80
Silicates	86·94
Peroxide of iron and alumina	1·22
Carbonate of lime	0·30
Magnesia	0·10
	98·28

It has been inferred from the fact that the *Kalmia* dies in the common soils of this region, that this effect is due to the presence of lime. This opinion, however, is disproved by the above analysis, which shows the existence of lime; and this element is obtained in a proportion still greater when the soil is thoroughly decomposed, and analyzed by means of fusion by carbonate of soda and potash. Thus, 100 grains gave

Organic matter	5·76
Silex	83·65
Peroxide of iron and alumina	8·70
Carbonate of lime	1·06
Magnesia	0·20
	99·37

I have analyzed two specimens of soil from the farm of Mr. Young, which lies upon the east slope of the lake, and is elevated about one hundred feet above it.

ANALYSIS OF THE SURFACE SOIL.

Water of absorption	3·17
Organic matter	5·08
Silicates	82·09
Peroxide of iron and alumina	8·00
Carbonate of lime	1·50
Magnesia	0·15
	99·99

SUBSOIL.

Water of absorption	3·00
Organic matter	2·87
Silicates	82·00
Peroxide of iron and alumina	8·20
Carbonate of lime	3·00
Magnesia	0·30
	99.37

The subsoil has more clay apparently, though the analysis does not indicate a difference of much importance.

Analyses of two specimens from the same farm.

SURFACE SOIL.

Water of absorption	3·16
Organic matter	7·44
Silicates	74.00
Peroxide of iron and alumina	8·30
Carbonate of lime	6·48
Carbonate of magnesia	0·50
Sulphate of lime	0·12
	100·00

SUBSOIL.

Water of absorption	4·15
Organic matter	3·75
Silicates	80·00
Peroxide of iron and alumina	10·00
Carbonate of lime	1·50
Carbonate of magnesia	0·35
	99·75

The Marcellus shales, and shales of the Hamilton group, which lie beneath the soil of this farm, are composed of the following elements:

Water of absorption	2·00
Silicates	50·00
Alumina and peroxide of iron	10·00
Carbonate of lime	36·90
Magnesia	1·00
	99·90

The shales of this range, which furnish undoubtedly a large proportion of the soil of the eastern slope of the lake, are more calcareous than those of the Helderberg range; and hence it is probable that the large percentage of lime which the soils of Aurora yield, is due to the composition of this range of rocks. It is apparent, too, from these and other analyses, that a calcareous shale yields a soil richer in carbonate of lime than does a pure limestone. The soil resting upon the Niagara or Onondaga limestone is usually quite deficient in this element. This results from the nature of the purer limestones, namely, the slowness of their disintegration.

A soil which rests on the same shales, three miles east of Manlius, has the following composition:

Water of absorption	2·00
Vegetable matter	6·00
Silicates	81·50
Peroxide of iron and alumina	8·00
Carbonate of lime	2·25
Magnesia	0·25
	99·75

A specimen consisting of 200 grains of soil, taken from Mr. Ellis's cornfield, based upon the same rock, on being subjected to the action of water, gave

Soluble matter	1·20
Mineral salts	0·80
Organic salts	0·40

The mineral salts consisted of

Silica	0·02
Chlorides of lime and magnesia	0·48
Sulphate of lime	0·07
Alumina	0·01
Carbonate of lime	0·20
	0·78

Most soils, if not all, yield soluble silica when thus acted upon by water. Sometimes it is inappreciable; at others, susceptible of an accurate determination. This substance, without doubt, is one of the essential elements of good grass or pasture land. All the cereals require silica, as much as they do carbon: hence, where there is a deficiency of soluble silica, we can not hope to obtain good crops of hay or grain. I omit here all details, except the common statement in regard to silex, reserving a more special notice of this substance for a future section.

The Marcellus shales, when subjected to the solvent power of water, furnish considerable soluble matter. Thus, 200 grains, treated as above, gave

Soluble matter	1·98 grs.
Organic mattter	0·63
Saline matter	1·35

The latter was composed of

Silex	0·03
Alumina or phosphate of alumina tinged with iron,	0·25
Chlorides of lime and magnesia	0·23
Sulphate of lime	0·12
Carbonate of lime	0·73
	1·35

A specimen of soil from the cornfield referred to above, treated in the usual method of analysis, gave

Water of absorption	4·15
Organic matter	5·06
Silex	80·15
Carbonate of lime	3·00
Magnesia	0·50
Peroxide of iron and alumina	7·00
	99·86

A specimen of soil which has never been cultivated, taken from the same geological position as the above, gave

Water of absorption	5·20
Organic matter	6·50
Silicates	89·05
Peroxide of iron and alumina	7·64
Carbonate of lime	2·05
Magnesia	0·25
	104·69

This soil, treated with water in the usual proportion, gave

Soluble matter	1·60
Organic matter	0·46
Saline matter	1·15

This consisted of

Crenate of lime	0·60
Silex	0·01
Sulphate of lime	0·40
Alumina	0·03
Chlorides of calcium and magnesium	0·10
	1·14

Another specimen of soil, taken from the range of hills between Manlius and Chittenango, but uncultivated, gave

Water of absorption	3·00
Organic matter	5·15
Silicates	78·00
Peroxide of iron and alumina	13·00
Carbonate of lime	1·00
Magnesia	trace.
	100·15

This field slopes rapidly, and is more washed than the preceding; and hence the soluble matters, as lime and magnesia, seem to exist in proportion less than in the preceding examples.

The analysis of these several specimens of soil was undertaken for the purpose of ascertaining whether they were composed of mineral matter in about the same or equal proportions, and the result shows that there is certainly a great uniformity in the composition of the soils reposing upon the Marcellus slates. It is not, however, intended to represent this slate as a compound whose elements are combined in definite proportions, or that the soil will be found identical in the same range; yet it seems that both soil and slate possess a composition quite similar, though taken from points twenty or twenty-five miles distant from each other. We deem this result to be one of the peculiarities of the New-York soils, and that it arises from the regularity of her geological formations. It is for this reason, too, that I have multiplied analyses. The mineral composition of the most important formations, when once ascertained, is susceptible of application to a wide extent of country. In support of this assertion, the reader may revert to the analyses of the soils resting on the Marcellus slate. The similarity of composition is seen in the quantity of silicates, and of lime, which each respectively furnishes, while the organic matter must necessarily vary with the circumstances of the example taken. The same fact is established in respect to the composition of the green shales of the Salt group, and the soil derived from them. It is also an interesting fact that this soil contains uniformly less calcareous matter than that of the Marcellus slate, although the former has twice or thrice as much carbonate of lime in its composition as the latter. This was a perplexing point at first; but if it is true, as it seems to be, that more of the organic salts are formed in the green shales in the course of decomposition, than in the Marcellus slate, the case may be regarded as explained. These salts, together with the salts of sulphuric acid, are soluble, and wash out or filter through the soil: hence the bitter waters of so many lakes, and the great abundance of tufa which accumulates on the slopes and declivities wherever the percolating waters are brought to the surface.

The soil of the valley of the Genesee possesses essentially the same characters as that of Onondaga county. This statement is borne out by the following analyses. Thus Mr. Harmon's wheat soil, in Wheatland, gave of soluble matter 1·41, containing organic matter 0·25, and saline matter 1·16, from which I obtained, after ignition, 0·52 of a grain of carbonate of lime, besides chlorine and sulphuric acid. The subsoil (200 grs.), treated with water, gave 3·25 grains of soluble matter, of which 1·63 was organic and 1·62 mineral salts. This combination yielded

Carbonate of lime	0·75
Sulphate of lime	0·22
Magnesia and alumina	0·46
Chlorides of calcium and magnesium	0·20
	1.63

The subsoil in this case is more tenacious than the surface soil, and illustrates the fact which is often referred to by agricultural writers, that clay bottoms and an impervious hardpan hold or retain the soluble parts of the surface soil, especially when under cultivation. In this instance the subsoil is strictly a stiff clay, and so compact and impervious that it necessarily retains water and the soluble matters which are carried down by filtration.

It frequently happens, however, that an analysis of a subsoil gives essentially the same result as the surface soil. This is the case where a soil is deep, and where consequently the lower materials differ but little mechanically from those of the surface; and as many of the western soils consist of deep beds of drift or the debris of shales, it is highly improbable that the soil and subsoil should give results differing essentially from each other: thus it is no uncommon circumstance for the earth from deep excavations to bear a heavy burden of corn or wheat the first season succeeding its exposure. The same fact is well known, too, in respect to the new and fresh soil from the shales of the Salt group. This is owing in part to the organic matter contained in the rock, and also to the fineness of its particles. These properties fit the abraded materials for the food of plants, so far as soils supply the wants of vegetation. The debris of granite, and other primary rocks, seems to require a long exposure to the air, and to the influences of light, water, carbonic acid, and the growth of the lower orders of vegetables, before the domesticated plants can be cultivated with profit upon the soil formed of it.

The rocks passing through the wheat district are arranged in terraces more or less distinct. These are formed by the hard limestones and shales: the former are abrupt; the latter present a gradual ascent or descent. As terraces, therefore, the former are more distinct than the latter, and present an approach to an elevated plain, while the shale terraces appear in the form of rounded hills descending on all sides, so that their surfaces admit the rapid disappearance of the water that falls upon them, by which they are liable to gully as well as wash; yet as slate is retentive of water, and its natural seams or joints are close and almost impervious, its slopes and summits feel a drought less than the soils resting upon limestone. The latter are traversed by cracks or open joints, which suffer the water to pass in streams, and thereby drain the surface to an injurious extent. In some instances limestone hills are insulated, or cut entirely off from the succeeding shales, and, if naked, or laid bare by denudation, would present on all sides a mural escarpment. It is easy to understand that in such cases the water escapes, flows out from the escarpments, and drains injuriously the whole tract insulated in the mode indicated above.

An analysis of the soil reposing upon limestone gives less lime than that reposing upon slate. I subjoin a few examples of analysis, which go to prove the truth of the position.

Analyses of the soils resting upon the Pentamerus limestone, at Manlius square.

SUBSOIL EIGHT INCHES BELOW THE SURFACE.

Water of absorption	1·48
Organic matter	2·80
Silicates	85·90
Peroxide of iron and alumina	8·57
Carbonate of lime	0·21
Magnesia	0·05
	99·01

This soil forms the first limestone terrace above the village, towards Chittenango.

SURFACE SOIL.

Water of absorption	2·81
Organic matter	4·59
Silicates	84·64
Peroxide of iron and alumina	7·28
Carbonate of lime	0·50
Magnesia	0·16
	99·98

The soil of this terrace is not supplied with a greater amount of drift than usual, and yet the quantity of lime is less than upon the Marcellus slate.

The Onondaga limestone forms another terrace above the preceding. The soil is porous, and bears good corn and wheat, but does not differ essentially from that of the Pentamerus limestone. It is composed of

Water of absorption	0·50
Organic matter	4·85
Silicates	85·50
Peroxide of iron	4·62
Carbonate of lime	0·62
Alumina	3·30
Magnesia	trace.
Loss	0·61
	100·00

The composition of the Onondaga limestone has been given. It contains a trace of phosphate of lime, and two per cent of magnesia; but as it is a hard rock, one which resists decomposition, it slowly furnishes food for vegetables.

The shales of the Salt group frequently give more magnesia than lime. A specimen taken from the farm of Mr. Geddes, of Fairmount, gave

Water	4·75
Organic matter	6·20
Silicates	75·62
Carbonate of lime	0·50
Magnesia	2·15
Alumina and iron	10·34
	99·56

This arises from the fact that magnesia exists in all the shales and thin-bedded limestones, from the red marl up to the pentamerus limestone, varying from two to eighteen per cent; and as it is less soluble than carbonate of lime, it is retained in the soil when the lime would disappear.

An uncultivated soil near Clyde, upon the Salt group, gave, on analysis,

Water of absorption	4·00
Vegetable matter	6·50
Silicates	78·82
Peroxide of iron and alumina	4·69
Carbonate of lime	3·71
Magnesia	1·75
Phosphate of alumina	0·24
	99·71

The two following specimens of soil were taken from the farm of Mr. Ira Hopkins, of Mentz, Cayuga county. The Salt group lies below, but the surrounding region contains much drift. The first was taken from a dry ridge which has been under cultivation many years, and has produced forty bushels of spring wheat to the acre.

ANALYSIS.

Water of absorption	3·84
Organic matter	10·44
Silicates	77·78
Peroxide of iron and alumina	4·98
Carbonate of lime	1·30
Magnesia	1·48
	99·82

The following soil is a clay loam, resting upon plaster shales:

ANALYSIS.

Water of absorption	5·10
Organic matter	5·94
Silicates	80·40
Peroxide of iron and alumina	5·00
Carbonate of lime	2·36
Magnesia	1·08
	99·88

If we compare the analyses of the soils and rocks below and above the bands of limestone which traverse the State from the Hudson river to Blackrock upon Lake Erie, we can scarcely fail to recognize the fact, that so far as composition is concerned, they are better adapted to the growth of the cereals than the limestones and their soils. This we deem an important point — one which must operate in the selection and choice of farms, and which must also throw some light on the mode by which the limestone soils may be cultivated to the best advantage.

Analysis of soil from Wheatland, Monroe county.

The first was from Mr. Bean's farm, and has been under cultivation for wheat many years.

ANALYSIS.

Water of absorption	5·70
Organic matter	5.92
Silicates	80·18
Carbonate of lime	0.40
Carbonate of magnesia	0·28
Phosphate of lime	0·12
Peroxide of iron and alumina	6·40
	99·00

A lighter and more siliceous soil is sometimes met with in the Wheat district : thus, in Lockport, Niagara county, I found a specimen composed as follows :

Water	3·00
Organic matter	5·00
Silicates	85·72
Carbonate of lime	1·00
Phosphate of alumina	0·04
Magnesia	trace.
Alumina and iron	5·00
	99·76

Another specimen of soil, from Niagara county, gave, on analysis,

Water	3·00
Organic matter	7·75
Silicates	76·93
Peroxide of iron and alumina	8·82
Carbonate of lime	2·82
Phosphate of alumina	0·15
Magnesia	0·25
	99·72

The following is an analysis of the most common wheat soil of Niagara county, and was taken from the farm of Mr. Devereaux, of Niagara falls :

Water of absorption	3·61
Organic matter	9·24
Silicates	70·88
Peroxide of iron and alumina	13·50
Carbonate of lime	0·34
Magnesia	0·04
	97·61

This soil is a clay loam, but deficient in carbonate of lime and magnesia. It has been cultivated many years, and principally for wheat: its produce is eighteen to twenty bushels to the acre.

The soils of Livingston county possess in general the same characters as those of Monroe, Genesee and Onondaga. They are strictly soils well adapted to wheat, which crop they have borne for many years in succession without a sensible deterioration. The soil is generally very deep, and seems, from its physical properties, to have been derived mainly from the limestone shales of the Salt group, which is well developed at the North. The rock beneath is a slate or shale, belonging to the Hamilton group. The Moscow shale, which is a rock ready to pass into disintegration, is quickly subdivided by the action of water and frost. It is a softer variety of the group, than those which lie farther east. The rock succeeding the Moscow shale, is the Genesee slate, which is also quite subject to disintegration, but forms a soil more sandy or siliceous than the rock below. It contains pyrites, which, in the course of decomposition, give origin to hepatic springs, of which some account will be given in the sequel. The general qualities of the soil appear in the exuberance of the vegetation, especially in the greenness and vigor of the forest trees. Of this, one may be fully satisfied by a survey of the Genesee flats near Mountmorris, Geneseo and Moscow. A traveller can not fail of observing a material difference in the vigor of vegetation, between parts of Livingston county, and some parts of Western New-York farther east, especially if the last are observed while the recollection of the vegetation of Livingston is still vivid in his memory.

The winters of Livingston are not so severe as in Albany county. The warmth of spring is earlier; but while the cold of winter is less, and the spring earlier, the season is not farther advanced the first of May, than in Albany and Columbia counties. The returning warmth is not sufficient to carry forward vegetation, though winter has passed and the spring has arrived: it is still spring, and not a summer whose influence is sufficiently genial to give an impulse to the vegetable kingdom, and carry it forward in its peculiar developments.

A large part of Livingston county belongs geologically to a group considerably above the Salt group of Onondaga, and which is regarded as the basis of the western wheat soil; still, the group does not attain an elevation equal to that of Otsego, and other more eastern counties. A depression seems to exist in the valley of the Genesee, by which the outcrop of the slates and shales is at a lower level; and for reasons which do not appear, the Hamilton group is not fully developed in the neighborhood of Geneseo and Moscow. The soil, which is very deep, even upon the high grounds south of Mountmorris, is derived from the shore of Lake Ontario and intermediate places: even the debris of this northern formation is found upon the highlands of Allegany. It is, however, only in the lowest vallies, and intervales along the main water courses, that the debris of the limestone shales is found in sufficient quantity to increase the wheat crop.

The following analyses have been made of the soils of Moscow, Mountmorris and Avon, which may be taken as representatives of the constitution of the soils of Livingston county, so far as the mineral composition is concerned.

A soil reposing upon the thin band of limestone, at the base of the Genesee slate.

ANALYSIS.

Water of absorption	2·81
Organic matter	5·19
Silicates	76·50
Carbonate of lime	1·62
Magnesia	0·50
Peroxide of iron and alumina	12·38
	99·00

This soil is regarded as a clay, and forms a soil quite stiff and impervious, but it is a durable wheat soil. The average production is fifteen bushels per acre. It is the basis of the soil for this crop through this section of country. Above it a soil is not uncommon, which is called locally a *wheat sand*, in contradistinction to a *wheat clay*. The former, however, is never a thick deposit, and it is usually sufficiently near the clay to be influenced by its presence. It is one excellence of the wheat clay and sand, that whatever manure is put upon them remains until used up by vegetation: a leachy soil, as it is called, is hardly known in the county.

Surface soil, from the range of elevated land west of Moscow village, resting upon the Genesee slate.

ANALYSIS.

Water of absorption	4·04
Organic matter	1·16
Silicates	82·70
Peroxide of iron and alumina	7·50
Carbonate of lime	1·75
Magnesia	0·50
	97·65

Soil taken from the farm of Mr. Horsford, nine inches below the surface, resting upon the Moscow shale.

ANALYSIS.

Water of absorption	2·00
Organic matter	1·12
Silicates	89·75
Peroxide of iron and alumina	4·21
Carbonate of lime	2·18
Magnesia	trace.
	99·26

The soils of Livingston contain less oxide of iron than is usual: hence they are of a light drab or clay color, which conveys the idea of coldness, and probably the power of absorbing heat is less than in soils which are red or brown.

Analysis of a specimen of soil from Castile, Wyoming county.

Its characters resemble those of Livingston, and it rests upon the same geological formation.

Water of absorption	2·50
Organic matter	8·25
Silicates	81·50
Peroxide of iron and alumina	5·91
Carbonate of lime	0·50
Magnesia	0·05
	98·71

Wheat soil of Niagara county.

ANALYSIS.

Water of absorption	3·00
Organic matter	7·75
Silicates	76·93
Carbonate of lime	2·82
Phosphate of alumina	0·15
Magnesia	0·25
Peroxide of iron and alumina	8·82
	99·72

Soil from North-Cambria, Niagara county, situated upon a ridge.

ANALYSIS.

Water of absorption	1·75
Organic matter	2·25
Silicates	88·53
Peroxide of iron and alumina	4·80
Carbonate of lime	0·70
Magnesia	trace.
	98·03

Washed sand of Niagara county.

ANALYSIS.

Water of absorption	1·00
Organic matter	1·00
Silicates and sand	84·75
Peroxide of iron and alumina	3·32
Carbonate of lime	8·04
Magnesia	1·47
	99·58

Analysis of soil from Kempville.

Water of absorption	2·00
Organic matter	2·50
Silicates	87·75
Peroxide of iron and alumina	4·32
Carbonate of lime	0·25
Magnesia	0·01
	96·83

Analysis of a sandy soil from Albion, Orleans county.

Water of absorption	1·50
Organic matter	1·70
Silicates and sand	92·82
Carbonate of lime	2·10
Phosphate of alumina	0·17
Peroxide of iron and alumina	1·49
	99·78

The soil of Orleans county contains usually more sand than that of Genesee, Livingston or Onondaga.

A question which I have attempted to solve in the analyses which have been recently made, is the constitution of the soils of the west, which are well known wheat soils; and how they differ from those of the Taconic system, which are well known producers of maize. I consider the question a difficult one to solve, and I deem it quite doubtful whether the facts which have been obtained will justify me in the adoption of an opinion. There are facts which may be still brought out, which will bear upon the question, and serve to elucidate it more fully.

The following results have been obtained in relation to the two classes of soils, which seem to be important, especially when taken in connexion with elements which enter into the composition of wheat on the one hand, and those which constitute maize on the other. Thus wheat is by no means rich in the phosphates, while corn or maize is; and hence the former will come to maturity in soils poorer in phosphates than the latter. Both grains, however, require silica, which must necessarily be in a soluble state. The straw, in one case, must be supplied with silex, or it will be weak and imperfect. Corn stalks require silex also, but a less amount than wheat. If then we search for the phosphates, and for soluble silica, I had hopes that some light would gleam upon the question. For illustration of this point, I took 400 grains of Harmon's wheat soil, and tested it for the phosphates; but not a trace of them appeared. The soil from Mr. Geddes's farm gave scarcely a trace of any in 100 grains. The same was observed in a good wheat soil, though not the best, on Manlius hills. The subsoil, or clay on Cayuga lake, near Aurora, gave no evidence of phosphoric acid in one hundred grains.

It is not designed to convey the impression that the phosphates are entirely wanting, but that they are contained in a proportion less than in soils, which, in New-York and New-England, bear good crops of maize, but are not so productive in wheat.

The following analysis of the soil of the Genesee flats is instructive, and bears upon the subject. It was taken fiom near Mountmorris, and may be considered as illustrating the composition of a large tract of country, that particularly which is of an alluvial kind.

ANALYSIS OF ONE HUNDRED GRAINS.

Water and vegetable matter	12·25
Silicates	74·65
Carbonate of lime	2·43
Peroxide of iron and alumina	8·75
Magnesia	1·00
	99·08

The 8·75 grs. of oxide of iron and alumina were redissolved in weak muriatic acid, and found to contain 4·16 of soluble silica.

The silicates were fused with carbonate of soda, and were found to contain

Pure silica	68·64
Peroxide of iron and alumina	4·93
Carbonate of lime	0·88
Magnesia	a large trace.

In this rich soil a trace of phosphoric acid seemed to exist, but it was not certainly detected, though sought for in both precipitates by caustic ammonia. The soluble silica, and carbonate of lime and magnesia, are present in very large proportions, and probably also the organic acids.

Some of the eastern soils, those of Hoosic in Rensselaer county, from the farm of Mr. Ball, were submitted to a careful examination for phosphates, with the following results:

Water	4·60
Organic matter	6·72
Silex	74·87
Carbonate of lime	0·15
Magnesia	0·12
Phosphates	0·20
	86·66

The alumina and iron contained 0·05 of soluble silica.

A still larger proportion of the phosphates has been obtained from the soils of the Taconic range, from Peekskill to Bridport in Vermont. As a general result, it may be stated that the phosphates are more abundant in the latter section, in the maize growing district, than in the wheat district, and the soluble silica is in greater proportion in the latter than in the former. The Harmon wheat soil, though it gave, in 400 grains, not a trace of the phosphates in the surface soil or subsoil, yet it gave a large amount of soluble silica. The matters soluble in water, however, the crenates particularly, abounded in the Wheatland soil; and to the presence of soluble silica, and the soluble organic matters, its excellence as a wheat soil may be attributed.

Of the natural manures of the wheat district.

Without doubt gypsum is the most important of those substances which are sometimes called *mineral manures.* I shall not, however, notice it in this place. It is confined to the Wheat district: not a ton could be gathered elsewhere in the whole State.

Next in importance to gypsum, is the shale of the Salt group, especially where it is accessible. There are several kinds, and they all contain carbonate of lime and magnesia, and organic matter, and, besides, are exceedingly decomposable under the ordinary atmospheric influences. Some of them furnish a large amount of sulphate of soda, and the deeper seated ones, the chloride of sodium in a free state, in addition to other chlorides with which this substance is mixed, and which will be spoken of in the sequel.

It can not be supposed that any of the mineral manures, except gypsum, are of sufficient importance to be exported out of the district. They admit only of use when accessible upon the estate, or the neighboring estates, where they are found: they are, however, very important and valuable.

The manures next in importance to the decomposing gypseous shales, are peat and fresh water marl, or carbonate of lime which is found at the bottom of lakes and marshes in a pulverulent form. Marl, however, is not always entirely pulverulent in this district: in many places, it is assuming the condition of tufa; but it may notwithstanding be regarded as a valuable substance, suitable in itself as an enriching material, and also as a fertilizer in virtue of its absorbent and retentive power for moisture. In this respect it ranks among the first in value, taking place in absorbent qualities next to peat.

There is a great supply of marl in all the central and western counties. It is impossible to enumerate the localities. Most of the smaller lakes and ponds, and the bottoms of marshes, throughout the whole district, contain it.

The composition of tufa differs in no respect from that of marl; in many tracts of land, it may be more useful, when coarsely pulverized and spread over the soil, than marl, inasmuch as it would both loosen a compact light soil, and furnish calcareous matter by solution. It is equally rich in organic salts. As a source for supplying quicklime, it is superior to any other form, and makes a beautiful white lime suitable for the finest works required in building.

Marl and tufa are composed mainly of calcareous matter, and, in composition, are much the same from whatever source, or from whatever place it may be obtained.

The following analysis of marl, from Christian hollow in Onondaga county, gives a fair result, and shows how it is generally constituted: it differs but little from chalk in chemical constitution.

Water	22·2400
Organic matter	0·5246
Carbonate of lime	75·4554
Peroxide of iron and alumina	0·6172
Silica	0·5554
Magnesia	0·6172

Two hundred grains, being boiled in a large quantity of pure rain water, gave of

Soluble matter	1·310
Matter rendered insoluble by ignition	0·118
Soluble silica	0·020
Carbonate of lime	0·466
Alumina tinged with iron	0·232
Magnesia	0·020
Chlorides not determined.	

A clay, which belongs strictly to the marls, and which is found extensively in Niagara county, has the following composition :

ANALYSIS OF ONE HUNDRED GRAINS.

Water and organic matter	3·24
Silicates	58·20
Peroxide of iron and alumina	20·76
Carbonate of lime	14·62
Potash	0·44
Soda and magnesia	2·42
	99·72
Soluble silica	0·69
Quantity of phosphates in 100 grains inappreciable.	

This marl is the product of a soft portion of the Medina sandstone. It appears to be a rich material. It is of an ash gray color, not very tenacious, and hence is adapted to clay as well as sandy lands. It may be looked for near the outcrop of the softer portions of the Medina sandstone. It can not fail of effecting a decided amelioration of all light soils, deficient in lime, alumina, and the alkalies.

Waters of the wheat district.

The slates and shales which cover so large a portion of the Wheat district, contain much soluble matter ; for this reason, the water contains also an unusual quantity of salts of various kinds. In some of the formations, the chlorides are far the most abundant ; in others, the sulphates.

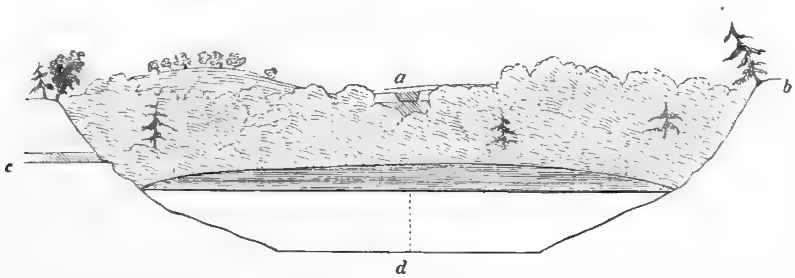
Limited sections of the district are deficient in surface water, in consequence of the open state of the natural joints of the rocks beneath ; but as a whole, the district is well supplied with water : it is, however, always hard, when obtained from springs or wells. The rivers which rise in the sandstone districts furnish soft water, or water comparatively soft. As an example of the hard waters of the district, I may refer to that furnished by the Hydrant Company of Syracuse. This water contains 40 grains of saline matter to the gallon, consisting of the sulphate of lime, alumina, and the chlorides of lime, magnesium and sodium. It is clear and transparent, but is disliked as a beverage by strangers.

The well waters contain generally from ten to thirty grains of saline matter. The well of Mr. Geddes of Fairmount, which is excavated in the green plaster shales, contains from 22 to 25 grains of saline matter to the gallon, which consists of the chlorides of lime and magnesia, together with the sulphate of lime, silica and alumina. Alumina and silica seem to be present in most spring, well, and even river waters. The silica is, no doubt, often in the form of infusorial shields and cases, as this class of animals are often abundant in fresh waters.

The water of the Genesee river contains 10·40 grains of saline matter in a gallon, consisting of the sulphate of lime, silica, alumina, and lime in combination with an organic acid. The quantity of saline matter is so small that the water washes, and may be regarded as tolerably soft. It must be remembered that the river rises in a sandstone district, which furnishes but a small amount of saline matter. The lakes, those especially which are excavated in the shales of the plaster and salt rocks, are more remarkable for the amount of saline matter which they contain. As an example of this kind of water, I may refer to the Green lakes of Manlius. These represent a large number of lakes whose basins have been formed in this remarkable formation, either by subsidence or by a peculiar kind of excavation. The basins bear a resemblance to a large crater; the sides being steep, and sometimes precipitous. The annexed sections illustrate the shape and appearance they present: they were furnished by my friend Dr. Linklaen, of Cazenovia, in the neighborhood of which place lakes in this formation are not uncommon.

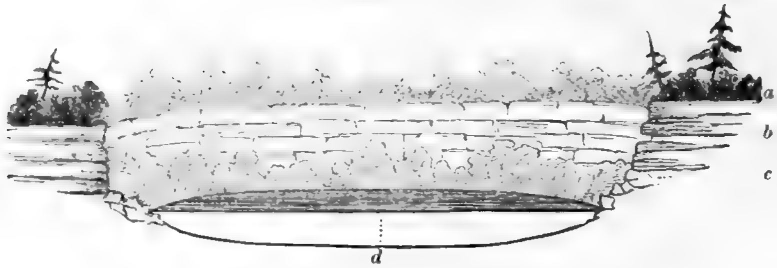
In fig. 34, *b* represents a steep sloping bank, from one hundred and thirty to one hundred and fifty feet high. The rock forming the bank is a shale of the Onondaga-salt group. In the same series is the gypsum, which is quarried at *a*. The vermicular rock appears at *c*. The depth is 156 feet at *d*. Whole diameter, 80 rods; mean depth, 150 feet. The entire depression, therefore, is 300 feet.

Fig. 34.



In fig. 35, the banks are perpendicular. In this case, the rim or brim of the lake is formed by the Onondaga limestone.

Fig. 35.



a. Onondaga limestone. *b.* Manlius waterlime. *c.* Talus. *d.* Depth 45 feet.

In regard to the mode in which these basin-shaped cavities were formed, it is Dr. Linklaen's opinion that it was by subsidence. An interesting paper, maintaining this view, was read by Dr. L. before the American Association of Geologists and Naturalists, at its meeting in 1846. This view is sustained by the form of the above banks; by the perpendicular, but circular walls; by the nature of the superior rocks, or those which form the lower parts of the basin; by the fact that subsidences on a smaller scale occur occasionally; and lastly, by the still undisturbed position of the surrounding rocks, or the rock which forms the sides.

The Manlius Green lakes, which are small but beautiful sheets of water, furnish about 100 grains of saline matter to the gallon, a large proportion of which consists of the sulphate of lime; a sufficient quantity, however, of the crenate of lime is dissolved, to impart a bitter taste. The vegetable matters which happen to get immersed in the waters of these lakes soon become incrusted with a calcareous deposit, a part of which is an apocrenate of lime. Another pond of the same character as the Manlius Green pond, and whose basin is excavated in the same shales, contains a little more than one half the proportion of saline matter.

The water of the Onondaga lake, which is also situated upon the salt and gypseous rocks, contains 51·68 grains of saline matter per gallon.

Skeneateles lake is quite free from saline matter. It contains, however, lime in solution. As an evidence of its comparative purity, it abounds in trout of a fine quality, some of which have been known to weigh twenty pounds. This lake is situated above the shales of the gypseous rocks. It is surrounded by the Marcellus shales and the Hamilton group; the latter rocks are quite siliceous, but the former contain a soluble salt of lime.

A class of waters which abound in this district, are the hydrosulphuretted waters, of which there are two orders: the first, and most common, are those whose principal salts are sulphates; the second, those whose salts are chlorides. Organic matter, in each order, seems to form the base with which the sulphur is combined. As an example of the first order, the Sharon springs are now the most eminent. They issue from the upper part of the Salt group, or rather from the shales just below the Manlius waterlimes. Springs similar to the Sharon are common in the same formation, from Schoharie county to Buffalo.

The facts brought to light by the phenomena of this range of waters, demonstrate that their characters depend upon the rock from which they issue. Where, for instance, hepatic springs issue from the rocks above or below, essential differences are known to exist.

According to Dr. Chilton, the water of the Sharon spring contains, in one pint,

Sulphate of magnesia	2·65
Sulphate of lime	6·98
Chloride of sodium	0·14
Chloride of magnesium	0·15
Hydrosulphuret of sodium and magnesium	0·14
Sulphuretted hydrogen gas, one cubic inch.	

An example of the second order of sulphur springs, is found upon the shore of Onondaga lake, near Syracuse. It contains, in a pint of water, 35·732 grains of saline matter, the major part of which is chloride of sodium. It gave, on analysis,

Chloride of sodium	30·420
Chloride of lime	4·822
Chloride of magnesium	0·490

The sulphuretted hydrogen is in combination with organic matter.

Another class of springs, of which only a few are known, are the sulphuric acid springs, or those springs which contain an excess of sulphuric acid. These springs are indicated by the charred vegetable matter through which the water issues. They are, I believe, peculiar to the Salt group, or issue only therefrom in this State. They may appear, however, as high in the geological series as the rocks which give origin to the Sharon springs.

The common sulphur springs are very abundant, and are known throughout the whole wheat region. In Moscow, and its neighborhood, sulphur springs issue from the Genesee slate, which are often highly bituminous.

A fact of considerable interest was reported to me, in regard to the efficacy of the milder sulphur waters in incipient phthisis. It was stated by Dr. Dwight of Moscow, that consumption rarely occurs in that neighborhood; and that persons who have already a cough, attended with irritable lungs, are benefited, and generally cured by the waters of this region, many of which are impregnated with sulphur and sulphuretted hydrogen. Strangers, with affections of the kind referred to above, after drinking the waters five or six weeks, are attacked with an eruption of the skin, which appears in the form of a fine rash. Soon after the appearance of this rash, the lungs are relieved.

A spring, containing less sulphuretted hydrogen than the Sharon spring, but more saline matter, has been discovered in Alden, Erie county, near Buffalo. One pint of the water contains 88·36 grains of solid matter, principally the chlorides of soda, lime and magnesia, and no sulphuric acid. A little iron falls to the bottom of a vessel in which the water stands, being an organic salt of iron: it contains more organic matter than suffices for the neutralization of the iron. The presence of organic matter in all the mineral waters of the State, is a fact of considerable interest, and which especially throws light upon their origin.

Sulphur springs are known from observation to issue from every geological formation in the State; indeed, almost every rock furnishes this kind of water. The Primary system gives origin to fewer springs of this description, than the superior ones. The production of the acid waters which have been briefly referred to, is probably due to the decomposition of waters which contain the sulphates. The decomposition may be brought about by organic matter; thus, near Cherryvalley, two acid springs, issuing from a marshy place in which there was a large deposit of peaty matter, had charred a thick mass over twenty-five feet in diameter. This black material was decidedly sour; and it seemed highly probable that the same waters beneath, and before they came in contact with the organic matter, were merely the common mineral waters which abound in sulphates. The acid springs of New-York belong, I believe, exclusively to the rocks near the Salt group. Decomposing pyrites, in contact with organic matter, as wood, in the Tertiary and Cretaceous formations, produce the acid sulphate of iron, by which the wood is not only blackened, but completely carbonized.

Another class of mineral springs abound in Central New-York, and constitute the well known salines, which consist principally of the chloride of sodium. These springs or wells have been fully described in Dr. Beck's Report on the Mineralogy of the State, and hence require here only a brief notice. For the purpose of giving instances of all the waters known, I deem it proper to give one or two examples of the analysis of these waters. Dr. Beck's analysis of the Salina and Syracuse wells of brine are therefore subjoined.

	Salina. Sp. gr. 1·110.	Syracuse. Sp. gr. 1·104.
Saline matter in 1000 grs.	146·50	139·53
Carbonate of lime	0·17	0·14
Sulphate of lime	4·72	5·69
Chloride of calcium	1·04	0·83
Chloride of magnesium	0·51	0·46
Chloride of sodium	140·02	132·39
Oxide of iron and silica, and carbonate of lime	0·04	0·02
Carbonic acid	0·09	0·07
Water, with a trace of organic matter and bromine,	853·41	860·40

The Salina water contains 1130 grains of pure and perfectly dry chloride of sodium in a wine pint, and 9045 grains or 1·29 pounds avoirdupois in a gallon: it therefore requires forty-three and a half gallons to yield a bushel of salt weighing fifty-six pounds. In the Syracuse well there are 1063 grains of dry chloride of sodium in a wine pint of brine, and 8506 grains or 1·21 pounds avoirdupois in a gallon; and hence it requires forty-six and a quarter gallons for a bushel of perfectly dry salt.*

* L. C. Beck's Report, pp. 105, 106.

A SERIES OF TABLES,

CONTAINING THE MOST IMPORTANT FACTS IN REGARD TO THE POSITION, CLIMATE, ETC. OF PLACES SITUATED WITHIN THE LIMITS OF THE WHEAT DISTRICT.

TABLE I. *Position of the several places.*

PLACES.	North Latitude.	West Longitude.	Elev. above tide.	Topographical remarks.
Auburn	42°30′	73°44′	650 feet.	In the valley of the outlet of Owasco lake, Cayuga county.
Cayuga	42 43	76 37	447 "	Sixty feet above Cayuga lake.
Lewiston ..	43 09	79 10	280 "	Eastern bank of Niagara river.
Rochester ..	43 07	77 51	506 "	On the Genesee river.
Onondaga ..	42 59	76 06		
Millville ...	43 08	78 20		

TABLE II. *Mean temperature of each month.*

PLACES.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual mean.	Highest and lowest degree.		Annual range.	Greatest monthy range.
Auburn ...	26·76	28·94	39·06	42·19	47·13	63·17	70·05	70·03	60·38	48·23	39·38	19·20	45·13	96	— 6	102	68
Cayuga ...	27·38	28·43	37·10	44·10	54·84	66·94	78·34	73·10	60·64	51·45	40·12	24·57	48·93	90	— 2	88	64
Hamilton..	26·08	26·13	37·20	45·73	52·01	62·02	66·97	69·28	56·15	48·82	37·09	20·23	45·73	92	—13	105	66
Lewist on..	29·19	29·93	37·59	50·80	54·58	49·93	71·81	72·71	59·99	50·39	38·85	26·26	47·67	95	— 4	91	60
Millville ..	28·38	29·71	39·38	45·90	53·28	64·93	70·96	71·59	58·10	51·57	40·07	25·73	48·38	96	— 3	99	68
Rochester .	28·05	28·10	38·41	46·42	53·78	64·56	69·58	69·35	58·80	49·01	39·41	23·78	47·44	102	— 0	102	64

TABLE III. *Prevailing winds in each month.*

PLACES.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Auburn......	S	SE	W	NW	NW	S	S	S	s&sw	S	S	SW
Cayuga	NE	S	NW	NW	N	N	N	S	S	S	S	S
Hamilton	NW	NW	NW	NW	NW	W	W	NW	NW	NW	NW	NW
Lewiston.....	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW
Millville.....	NW	SW	NW	NW	NW	SW	SW	SW	NW	SW	SW	SW
Rochester	W&NW	W	NW	NW	NW	NW	NW	NW	NW	SW	NW	NW

TABLE IV. *Rain gage for each month.*

PLACES.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Auburn	4·72	2·74	1·47	2·61	2·67	1·76	2·89	2·05	4·10	3·66	4·27	1·48	34·42
Cayuga	0·40	0·25	1·65	2·91	1·71	2·22	2·21	1·54	2·03	1·07	2·50	....	
Hamilton	2·94	4·25	2·69	2·63	2·31	1·75	2·03	0·94	3·26	2·68	2·72	1·38	29·61
Millville	3·22	1·64	2·21	3·76	2·52	1·39	2·11	1·21	4·37	1·70	1·77	0·37	26·27
Rochester	3·51	2·01	2·62	2·49	2·65	4·48	2·75	2·77	4·32	2·84	2·58	1·42	34·44

TABLE V. *Mean temperature for ten years from* 1826 *to* 1835, *both inclusive.*

PLACES.	1826.	1827.	1828.	1829.	1830.	1831.	1832.	1833.	1834.	1835.	Average.
Auburn	.....	48·24	49·96	46·36	43·37	.....	46·92	47·80	48·93	46·54	47·76
Cayuga	.....	.....	.....	.....	49·47	48.48	48·10	.....	48·08	.....	48·53
Hamilton	.....	45·03	47·46	44·48	45·87	45·70	.....	44·99	44·49	43·83	45·23
Lewiston.....	....	.....	.....	.....	.....	49·32	49·29	49·69	50·70	47·36	49·31
Onondaga	50·71	48·27	50·90	47·81	.....	.....	50·21	47·81	.....	46·84	48·93
Rochester	.....	.....	.....	.....	49·27	.....	.....	48·18	47·48	47·40	48·08

TABLE VI. *Comparative view of the quantity of rain for ten years, from* 1826 *to* 1835, *both inclusive, so far as reported.*

PLACES.	1826.	1827.	1828.	1829.	1830.	1831.	1832.	1833.	1834.	1835.	Average.
Auburn	.....	.....	34·91	30·54	37·88	.....	30·87	34·00	24·70	34·33	34·46
Cayuga	.....	35·59	.....	.....	37·11	36·10	29·06	.....	25·09	.....	32·59
Hamilton	.....	43·44	34·18	33·26	42·71	35·79	35·38	43·20	32·50	.....	37·55
Lewiston.....	.....	.....	.....	.....	.....	25·35	21·45	20·73	22·55	25·68	23·15
Onondaga	26·67	38·09	35·79	27·10	.....	.....	28·20	26·79	.....	35·43	30·72
Rochester	.....	.....	.....	.....	34·94	.....	.....	.....	17·84	28·60	27·16

TABLE VII. *Comparative view of the average temperature, for each of the last ten years, so far as reported to the Regents.*

PLACES.	1836.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	Average.
Auburn......	44·75	46·17	45·11	47·25	47·55	46·56	44·62	45·52	48·32	45·13	46·00
Cayuga......	.....	.....	43·05	.....	49·67	50·51	51·62	48·51	47·52	48·93	48·53
Hamilton....	40·45	.....	.....	44·05	.....	.....	44·51	44·36	44·71	45·73	43·97
Lewiston....	43·54	44·50	.....	46·91	48·94	48·85	47·87	46·77	47·76	47·67	46·98
Millville.....	.....	.....	.....	.....	44·81	45·02	45·94	45·04	46·69	48·38	45·98
Onondaga....	45·16	45·24	46·06	46·96	47·63	46·89	45·19	44·00	45·17	.....	45·81
Rochester....	44·01	43·71	45·04	47·57	46·74	45·40	46·79	45·20	47·29	47·44	45·92

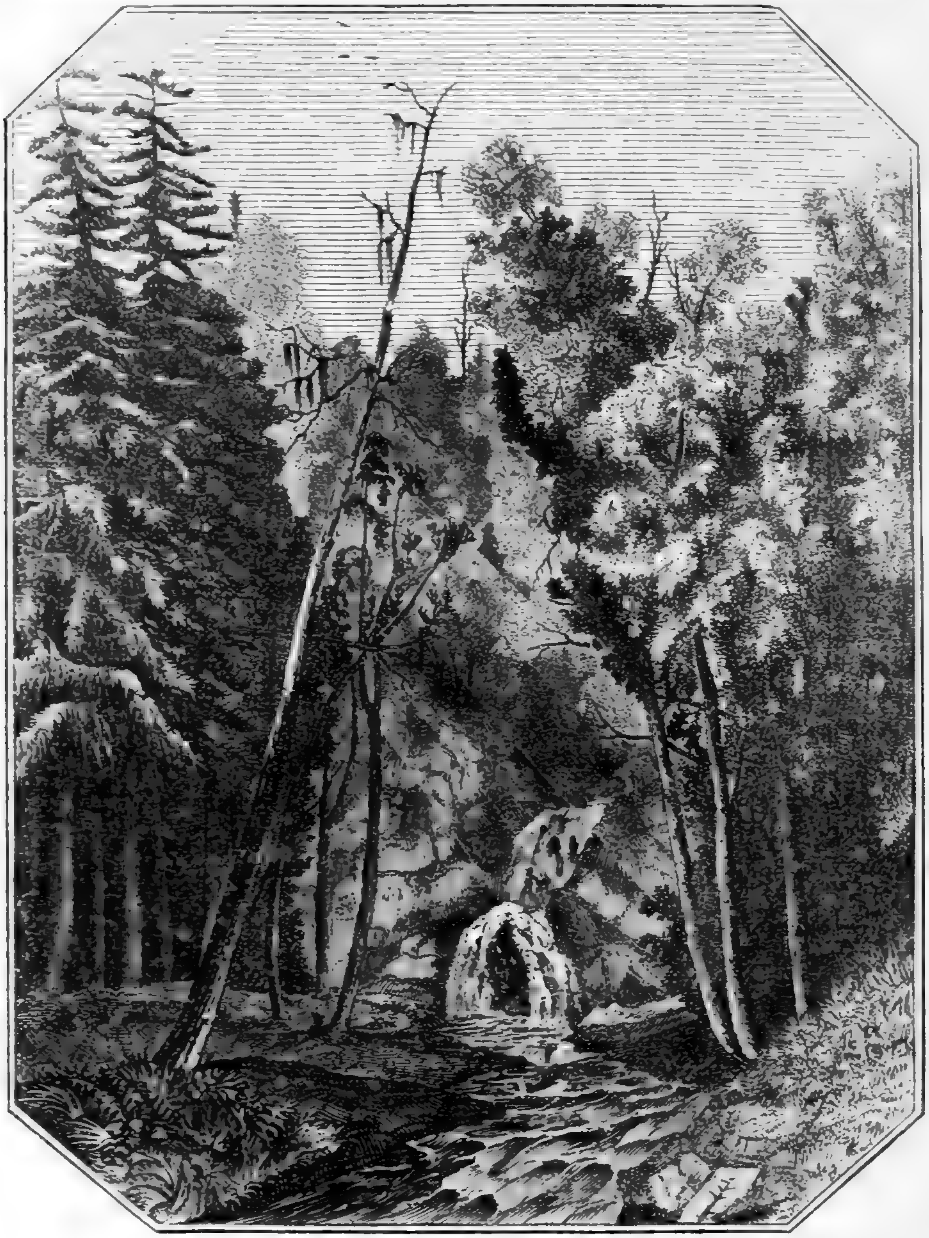
TABLE VIII. *Comparative view of the quantity of rain for the last ten years, which has fallen in the wheat district, so far as reported to the Regents.*

PLACES.	1836.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	Average.
Auburn	31·41	29·03	21·74	33·42	37·48	28·18	40·83	50·06	39·78	34·42	34·60
Cayuga......	.....	.....	.....	.....	.....	.....	.....	.....	26·72	.....	26·72
Hamilton....	40·05	.....	.....	35·11	.....	.....	37·18	32·87	25·55	29·61	33·39
Lewiston.....	.....	.....	.....	17·73	23·07	19·00	18·58	.....	.....	.....	19·59
Millville.....	....	.....	....	.....	.....	.....	30·86	26.54	23·74	26·27	26·85
Onondaga....	34·35	32·85	30·35	32·53	35·05	26·44	34·60	34·41	26·82	.....	31·93
Rochester....	27·95	30·61	25·46	30·09	29·34	30·53	33·19	36·21	26·17	34·44	30·80

TABLE IX. *General Summary.*

PLACES.	Mean temperature.	Prevailing winds.	Av. quantity of rain.
Auburn......	18 years, 46·78	18 years, NW&S	17 years, 33·73
Onondaga....	16 " 47·18	16 " W	16 " 31·40
Hamilton....	14 " 44·89	16 " NW	14 " 35·77
Lewiston.....	14 " 47·81	14 " SW	
Rochester....	14 " 46·54	14 " W	13 " 39·95
Cayuga......	....	12 " S	

Forest vegetation of the Southern district, as exhibited by a view in Gilboa, Schoharie county.



5. SOUTHERN DISTRICT.

A difference in the natural productions of the higher grounds of the southern tier of counties, or those bordering Pennsylvania, has not escaped the notice of agriculturists; and a hasty reference to my geological observations on this part of the State, is all that will be necessary to convince an unprejudiced person that many of the differences which have been observed in the natural as well as the cultivated productions, are due to the peculiar formations of this portion of the commonwealth. Height undoubtedly exercises considerable influence upon the vegetation of this district, but it is not probable that to height alone can be attributed the differences which have been observed in respect to the products of the soil.

For the purpose of a general reference, the northern limits of the Southern district extend to the middle of Seneca and Cayuga lakes. This boundary line, prolonged east and west as far as to the spurs of the Catskills, or the head waters of the Mohawk and Lake Erie, completes the northern boundary of the district. Otsego, Schoharie, Greene and Albany counties, intercept this line eastwardly. The vallies of these counties, however, contain much valuable wheat soil; but it is not continuous to a great extent: it does not produce the perfect grain in its seasons. The straw is weak, and the grain more liable to shrink. It is not full and plump as the wheat of the Genesee valley and the adjacent districts.

This district is hilly, and the vallies which traverse it are narrow. From this district, too, the waters flow both to the north and south. Without being precipitous, as in the Highland district, it is still quite steep in the ascents and descents; and a very large proportion of the farming operations are conducted on the slopes of ridges and hills, all of which were originally covered with a heavy growth of timber. Upon the higher grounds, the hemlock, spruce and fir are the most common. In many places, a mixture of beech, birch, maple, ash, hemlock, pine and spruce, is the form which the vegetation assumes. Its growth is heavy and dense, the character of which is well exhibited in the cut on the preceding page.

The soil is usually deep, sometimes in consequence of the accumulations which probably were made during the Drift period, and partly from the friable nature of the rocks beneath. These rocks, for moderate distances, appear horizontal. Uplifts have rarely deranged the original position of the strata. Immense sections of the rocks, however, have been removed; and hence the sides of the vallies have their corresponding strata upon the same level. The debris of the rocks so far modify the accumulations of drift, that it gives the soil a peculiar character, and fits it for certain kinds of husbandry. Butter, cheese, wool, and the rearing of cattle, become objects of prime importance.

We may now inquire more particularly what peculiarity in the composition of the soil controls the husbandry of this district? We have no doubt it is principally the composition of the soil that creates the differences we have just alluded to. More ammonia, if we may credit the opinions of foreign agricultural chemists, must necessarily be showered upon the hills and vallies as more snow and rain fall; and yet there is less fertility, or it may perhaps be said more properly, that the fertility runs in channels differing from those of the other districts.

The first analyses which we propose to state, are those of soils within the territorial limits of the Wheat district. They were selected from Mount Toppin, and near Lafayette square in Onondaga county, at an elevation of six or seven hundred feet above the level of the canal at Manlius centre. Both soils are uncultivated, and that from Mount Toppin was taken from the forest.

Soil of Mount Toppin.

ANALYSIS.

Water of absorption	3·68
Organic matter	6·84
Silicates	81·32
Peroxide of iron and alumina	7·62
Carbonate of lime	0·25
Carbonate of magnesia	0·15
	99·86

It contains also a trace of the phosphate of alumina and peroxide of iron. The color of this soil is brown, and it contains a few fragments of primary rocks, some from the Medina sandstone, and many belong to the strata of the Hamilton group upon which the soil reposes.

Soil of Lafayette square.

ANALYSIS.

Water of absorption	4·68
Organic matter	5·25
Silicates	82·32
Peroxide of iron and alumina	6·62
Carbonate of lime	0·25
Magnesia	0·12
	99·24

The color of this soil is yellowish brown, and it contains but few pebbles: it belongs also to the Hamilton group. The composition of both is nearly, and indeed really, the same. In the summary which I propose to give, a more thorough analysis of both soils will be exhibited, which will show the capabilities of the soil from the hills and slopes adjacent to the wheat-growing vallies.

Notwithstanding these soils were taken from the extreme northern part of the Southern district, they represent very perfectly the composition of the soil of the whole district. We at once observe a great diminution of the quantity of lime and magnesia, and it is highly probable that potash and soda are also proportionally reduced in amount. Vegetable or organic matter may abound, and yet the oxygenized products are deprived of their bases; for the soil is deficient in the bases for which these products have an affinity.

The next soil of which an analysis was made, was taken eight inches beneath the surface, upon the slope near the inclined plane at the village of Ithaca.

ANALYSIS.

Water of absorption	1·94
Organic matter	3·62
Silicates	87·12
Peroxide of iron and alumina	6·28
Carbonate of lime	0·60
Magnesia	0·12
	99·68

This analysis gave a larger amount of lime than is usually obtained from the soils of the district. It is, however, still too small in quantity to support a yearly cropping without a sensible loss of fertility.

The Hamilton group furnishes a soil which is nearly identical throughout the State. In confirmation of this statement, we subjoin the analyses of a few additional soils, which were evidently derived from this series of rocks.

Soil from Gainsville.

ANALYSIS.

Water and vegetable matter	7·60
Silicates	81·26
Carbonate of lime	0·12
Magnesia	trace.
Peroxide of iron and alumina	10·30
	99·28

This soil contains the greater part of its available lime in combination with a soluble organic acid. Color of the soil dark brown; and it is easily pulverized, and, in drying, does not become lumpy, or adhesive when wet.

Soil from Greene county, near Mr. Stewart's, Greenville.

Color light yellow or drab: it is full of rounded pebbles and fragments of thin sandstone, accompanied with the fossils of the Hamilton group.

ANALYSIS.

Water and vegetable matter	6·00
Silicates	85·00
Carbonate of lime	0·75
Magnesia	0·25
Peroxide of iron and alumina	8·12
	100·12

The silex is nearly in the form of rounded grains of quartz.

Soil from near Loon lake, in Chemung county : uncultivated.

ANALYSIS.

Water and vegetable matter (water principally)	8·50
Silicates	81·00
Peroxide of iron and alumina	10·00
Carbonate of lime	0·15
Magnesia	trace.
	99·65

This soil is rather a stiff loam, and occupies one of the high vallies in Chemung county ; it forms a favorable compound for pasturage. It is deficient in lime and magnesia, and also in organic matter. Color yellow, and texture rather hard.

Soil from Howard, Steuben county.

ANALYSIS.

Water and organic matter	9·50
Silicates	80·50
Peroxide of iron and alumina	9·25
Carbonate of lime	0·25
Magnesia	trace.
	99·50

The color of the soil is drab ; it is easily reduced to a powder, and is not lumpy after being wet. It is dry and granular in its natural state, and is a tolerable grass soil.

Soil from the eastern slope of the Schoharie range.

Decomposed cauda-galli grit.

ANALYSIS.

Water	1·50
Silicates	88·50
Peroxide of iron	3·25
Alumina	5·28
Carbonate of lime	0·06
Magnesia	trace.
	98·59

Soil of the Old Red Sandstone, taken from the northern slope of the Catskill range, in Windham, Greene county.

ANALYSIS.

Organic matter	5·00
Water of absorption	7·00
Silicates	80·00
Peroxide of iron and alumina	5·50
Carbonate of lime	0·25
Alumina	3·50
	100·25

Another, but a forest soil, from near the top of the Catskill mountain, gave

Water and vegetable matter	24·00
Silicates	69·00
Peroxide of iron	2·17
Carbonate of lime	0·75
Alumina	3·67
	99·59

By this analysis we obtain the full amount of lime, which the soil of the Old Red Sandstone contains. Under cultivation, this is speedily reduced; and hence, in order to grow crops which require lime, the farmer must add it to his manures.

The soil formed by the debris of the red rocks of the Catskill mountain range is generally a light, but quick soil. It is warm and early, but does not stand a drought as well as many soils, when cultivated for corn, or any of the hoed crops. It furnishes the finest feed for grazing; and the butter which is made from cows feeding upon the rather steep slopes of the Catskill range, either of Greene or Delaware counties, is probably superior to any in the State. There is a richness and freshness in the dairy productions of the Catskill ranges, which makes them in greater demand in the city of New-York, than those from other parts of the State. The superiority of the Orange county butter arises from the excellent condition in which it is packed for market, not from its superiority in quality and sweetness.

Another analysis of soil from the Hamilton group gave

Water and organic matter	7·00
Silicates	85·25
Peroxide of iron and alumina	6·62
Carbonate of lime	0·50
Magnesia	0·50
	99·87

A watery solution gave organic acid in combination with lime, and also a trace of sulphate of lime. This analysis gives as much lime as the best of the soils above the Marcellus shales, except in a few cases, where, from the operation of local causes, the lime is increased. Such is the fact in parts of Onondaga and Cortland counties, where a drift soil contains a large percentage of calcareous matter, which seems to be derived from decomposing calcareous shales.

Soil taken from Fultonham, Schoharie county, from the Hamilton group.

ANALYSIS.

Water of absorption	5·00
Organic matter	4·50
Silicates	82·51
Peroxide of iron and alumina	8·00
	100·01

Very little lime or magnesia appeared in this soil. A watery solution gave the former in combination with an organic acid. Probably, however, the silicate of lime would be found by the process of fusion with soda or potash.

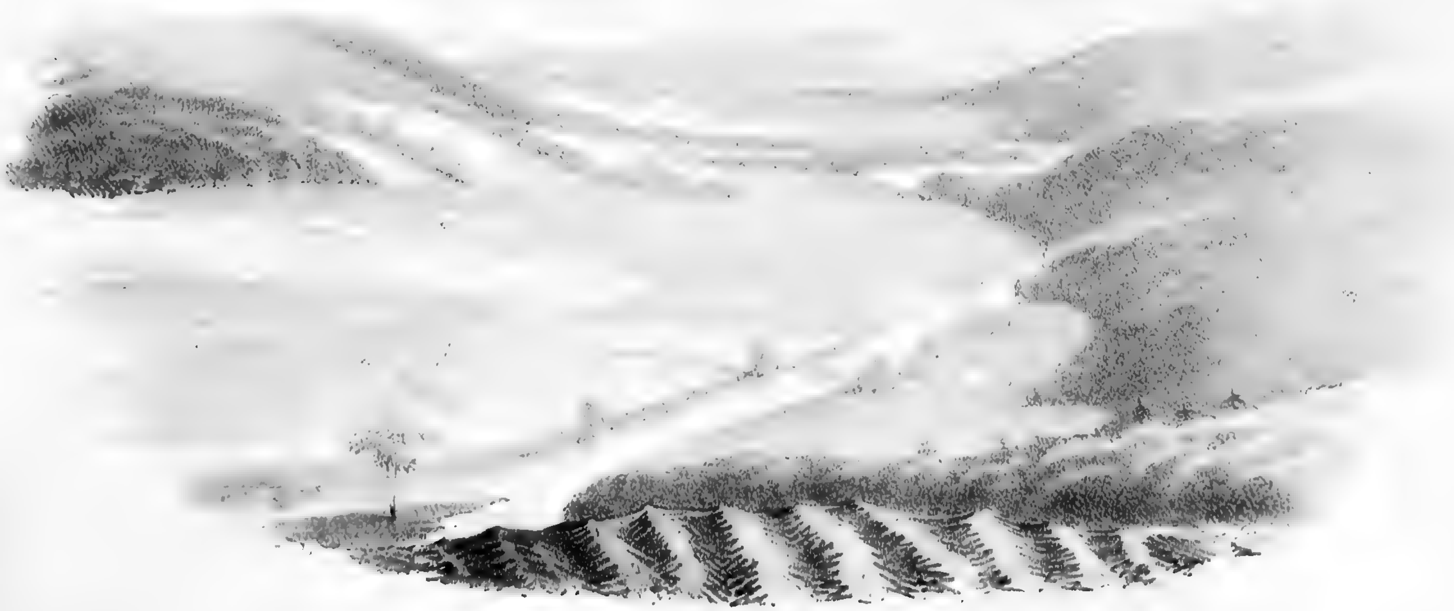
The soil of Schoharie flats, which must be a mixture of materials from many rocks, gives a better analysis than any of the preceding.

Water of absorption	2·00
Vegetable matter	6·00
Silicates	83·00
Peroxide of iron and alumina	6·50
Carbonate of lime	1·00
Magnesia	0·50
Phosphate of alumina	0·12
Sulphate of lime	0·14
	99·26

The watery solution gave organic matter and sulphate of lime. This is a rich corn land. The soil is dark brown, and is never lumpy after being wet, but dries and becomes readily pulverulent. We have given the analysis in connection, as it forms a contrast with the poorer soils of the upper rocks of the adjacent hills.

In the preceding analyses, it is assumed that the soils of the rocks above the Hamilton group do not differ essentially; hence it is not attempted to make a distinction between the former and the latter. The soil of the Old Red Sandstone is red, and contains more iron in a state of peroxide: it forms a very excellent quick soil, and is admirably adapted to grazing.

PLATE XI.



E. EMMONS Jr. DEL.

G. & W. ENDICOTT'S LITH. N. YORK

LIMESTONE, MARL AND PEAT, AND MEANS FOR SUPPLYING MANURES.

The Southern district is deficient in limestone. The only calcareous rock which extends south of the Wheat district proper, is the Tully limestone: it lies between the Hamilton group and the Genesee slate. It appears about two miles northwest of Deruyter village, at Tinker's falls, Tully four-corners, and at Otisco, where it caps Ross's hill. The shales above and below are fragile, but wanting in calcareous matter; yet they are useful to a certain extent in renovating the soil, when conveniently situated.

The Tully limestone appears also on the east side of Skaneateles lake, where it is only about fourteen feet thick; hence its influence on the soil, even along its outcrop, must be inconsiderable. It is, however, important as a means of furnishing lime for agricultural purposes. Analyses of the soils from a large part of the Southern district, show, in the most satisfactory manner, a want of this material, and experience proves its great utility.

South of the outcrop of the Tully limestone, the only deposit which can be employed for lime is the lake or freshwater marl. In several parts of this district, marl is quite abundant; and, in a few instances, it is burnt for lime. Its condition is extremely favorable for manufacturing lime. It is shovelled directly from its bed, into a mould of twice the length of a brick. On drying, the marl hardens, and may then be laid up into a kiln and burned. The lime is fine and white, and excellent for many purposes. There is, however, too much indifference on the subject, and hence not a hundredth part of the lime is used which ought to be. The marl ponds occupy many circular basins or depressions in the Hamilton group, and even in the superior formation. Many exist in Preble and Cortland.

Some of the marl beds are overlaid with peat, but it is less common in the Southern than in the Wheat district. Of course, where these two formations, marl and peat exist, farmers ought never to complain of the scarcity of the means for improving their soil.

The difference in the value of peat arises, in a great degree, from a difference in the quantity of soluble silex which it may contain. Some indication of its value may be obtained by a careful inspection of the matters, or of the class of plants, from which it is derived. If stems of the grasses are detected in the moss or peat, it will contain soluble silica, the presence of which fits the peat especially for a manure adapted to the cultivation of wheat, oats and corn, or the cereals generally. If it is found to consist mainly of moss or swamp sphagnum, less soluble silex may be expected; still it will be found extremely valuable.

Peat should be dug or cut and pressed, if designed for burning. If it is intended for manure, it should be composted while yet moist, and mixed with other matters. The silex, by this course, is maintained in a soluble state.

It is proper that the agriculturist should know, that by silex contained in peat, we do not mean sand, or dirt, which may be mixed with it. The silex which is spoken of here, is that which has been received into the composition of stems of grasses, and it remains in a soluble condition so long as it is moist. When thoroughly dried, and especially when burnt, the silex becomes insoluble, and is not fit to be assimilated immediately by the organs of plants.

We have often spoken of the importance of using peat before it is dried, or baked in the sun. When used in a dry state, or mixed in lumps in a soil, it will certainly disappoint the farmer; but when mixed into a compost with ashes, lime and other refuse matter, it will always be found useful. When used in a proper quantity on wheat lands, the berry will rarely if ever shrink; and could farmers in all parts of the State secure a supply of marl, peat, lime and ash compost, wheat of the finest quality might be raised equally well in all the districts.

The composition of the marls of this district is quite uniform. The analysis of one was given while upon the soils of the Wheat district, and which belongs as much to the Southern as it does to the Wheat district. Peat contains from 85 to 92 per cent of organic matter, all of which is capable of being converted into an organic acid, which dissolves the alkaline and earthy bases; and unless these bases are dissolved, they are useless to plants and animals. It is believed that even silica will yield to the action of the organic acids, a substance which, under ordinary circumstances, is among the most insoluble of bodies.

Waters of the southern district.

In no part of the State are waters generally purer than those which form the mountain and valley streams of this district. They possess the same characters, in general, as those which belong to the Highland or Primary district. Local exceptions may be not unfrequent. Even the Genesee river water, at Rochester, contains only 10·40 grains of foreign matter to the gallon. The principal exception which ought to be made to the above statement, is in respect to those waters which rise out of the Genesee slate. Springs originating here are often ferruginous, and contain organic matter in combination with various bases, and indeed it is quite common for them to contain much sulphuretted hydrogen in combination with organic matter. Taking the whole district, however, into account, the waters may be said to be pure, and fitted for domestic uses. They may be used in steam boilers, without fear of forming incrustations.

From this fact, namely, the general purity of the waters of the district, we did not deem it necessary to institute a series of analyses as in the preceding districts. We shall now bring our remarks to a close, after giving, in a series of tables, the most important meteorological facts which we have compiled from the Regents' reports.

A SERIES OF TABLES,

SHOWING THE PRINCIPAL FACTS IN METEOROLOGY, SO FAR AS THE SOUTHERN DISTRICT IS CONCERNED.

TABLE I. *Names of places, latitude, height, etc.*

PLACES.	North Latitude.	West Longitude.	Elevation.	Topographical remarks.
Franklin...	42°34′	77°20′		
Fredonia...	42 26	79 24	144 feet above Lake Erie.	2½ miles from the lake.
Hartwick ..	42 38	75 01	1100 feet above tide.	On a tributary of the Susquehannah.
Ithaca	42 27	76 00	417 feet above tide.	Head of Cayuga lake, and 30 feet above it.
Oxford ...	42 28	75 32	961 feet above tide.	Valley of the Chenango.
Pompey....	42 56	76 05	1300 feet above tide	900 feet above Salina or Syracuse.

TABLE II. *Mean temperature for each month*, 1845.

PLACES.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual mean.	Highest and lowest degree.		Annual range.	Greatest monthly range.
Cortland, ...	26·70	26·44	36·41	45·83	53.05	62·93	65·06	65·69	55·63	49·93	37·97	21·33	45·37	95	— 9	104	72
Franklin	29·71	29·41	38·81	46·96	53·26	63·21	67·20	68·59	56·48	48·21	39·78	21·83	46·95	98	— 6	104	70
Fredonia	34·62	34·21	43·63	51·62	56·07	67·11	70·61	71·71	61·31	53·08	42·53	28·20	51·22	96	— 4	92	58
Ithaca	30·33	29·98	39·85	48·93	57·04	62·98	71·03	70·99	60·84	52·08	42·53	23·56	49·18	97	— 4	101	56
Oxford	25·50	24·45	35·40	44·00	51·47	62·93	68·38	67·84	55·63	46·36	36·08	18·65	44·67	93	—16	109	67
Cherryvalley,	24·87	23·32	34·85	42·69	53·59	62·92	69·82	67·85	57·65	51·63	40·45	18·41	45·67	85	—17	102	65
Hartwick ...	31·75	31·11	42·46	50·24	58·89	68·81	71·78	72·55	61·53	54·28	43·09	26·31	51·06	94	— 7	101	65

TABLE III. *Prevailing winds in each month*, 1845.

PLACES.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Cortland	NW	NW	NW	NW	NW	SW	NW	SW	SW	SW	SW	NW
Franklin	NW	S	NW	NW	S	NW	NW	NW	NW	S	W	S
Fredonia	W	S	S	SW	S	W	W	w&s	S	W	W	N&W
Ithaca	NW	NW	NW	NW	NW	NW	NW	NW	NW	sw& NW	NW	NW
Oxford	NW	NW	NW	NW	NW	SW	NW	NW	NW	SW	SW	SW
Cherryvalley .	SW	W	W	NW	NW	NW	NW	S	NW	sw& NW	SW	SW
Hartwick	S	NW	S	S	NW	S	NW	S	NW	S	S	NW

TABLE IV. *Rain gage for each month.*

PLACES.	January.	February.	March.	April.	May.	June.	July.	August.	September	October.	November.	December.	Total.
Franklin	2·35	2·85	1·75	3·00	2·75	2·10	0·15	1·60	3·50	5·22	1·65	1·30	28·52
Fredonia	2·51	1·38	2·37	3·07	2·08	3·73	2·07	2·24	6·50	2·10	3·08	0·97	32·10
Ithaca	2·13	2·65	2·91	3·42	2·26	2·07	2·78	2·30	3·40	3·85	3·35	0·82	31·90
Oxford.......	2·57	1·22	2·87	2·77	2·44	5·08	3·04	1·61	4·34	3·90	2·20	1·28	33·32
Cherryvalley .	0·98	2·71	3·02	3·02	2·75	3·66	3·05	2·44	4·36	3·62	4·46	1·35	35·42
Hartwick	2·92	1·95	3·40	2·79	3·57	4·10	4·42	1·94	4·68	5·82	4·57	1·59	41·75

Average quantity of rain for the district, 33·80.

TABLE V. *Mean temperature for ten years from* 1826 *to* 1835, *both inclusive.*

PLACES.	1826.	1827.	1828.	1829.	1830.	1831.	1832.	1833.	1834.	1835.	Average.
Cherryvalley .	.... .	44·01	47·08	44·33	45·17	44·88	44·78	44·55	45·22	43·44	44·83
Cortland	....	.....	.....	.....	.....	.....	45·59	45·68	.....	43·17	44·81
Fredonia	.....	.....	.....	.....	49·57	47·83	42·23	.....	50·44	47·21	48·85
Franklin	.....	.....	.....	44·61	46·38	.....	.....	.....	.....	.....	45·49
Hartwick	46·60	45·40	46·94	45·49	46·68	43·96	45·89	.....	.....	45·39	45·79
Ithaca	.....	50·00	51·35	.....	49·67	.....	.....	48·28	.....	46·31	49·12
Oxford	.....	.....	.....	44·99	46·55	46·19	.....	44·22	45·83	44·32	45·34
Pompey......	45·97	43·50	47·33	43·38	44·68	43·08	43·40	43·12	.....	42·16	44·06

TABLE VI. *Mean temperature for the last ten years, so far as reported.*

PLACES.	1836.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	Average.
Cortland	42·04	42·70	43·30	44·00	45·39	44·55	45·36	45·02	43·81	45·57	44·17
Cherryvalley .	41·25	.....	.....	42·36	.....	42·97	44·28	42·36	44·11	45·67	43·28
Fredonia.....	44·54	46·02	45·63	46·75	48·04	48·40	49·94	49·17	50·08	51·22	47·98
Franklin	.....	.....	.....	35·81	45·28	44·49	44·48	44·10	45·67	46·95	43·82
Hartwick	44·96	43·65	.....	45·19	.....	.....	.....	.....	.....	51·06	46·20
Ithaca	44·28	49·33	44·96	45·71	47·95	.....	48·89	47·37	49·06	49·18	47·41
Oxford	42·80	43·77	43·45	45·79	45·95	45·24	41·82	44·84	44·38	44·67	44·37
Pompey	40·18	40·02	40·27	42·41	42·65	42·13	42·29	41·72	.....	.....	41·45

TABLE VII. *Quantity of rain for each of the last ten years.*

PLACES.	1836.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	Average.
Cherryvalley .	38·06	.....	.....	.....	.....	38·00	46·43	44·12	34·24	35·42	39·38
Fredonia	36·45	39·74	31·85	30·45	39·90	33·91	34·40	30·13	39·14	32·10	34·81
Franklin	.....	.....	.....	31·23	38·84	30·06	40·35	36·48	29·04	28·52	33·50
Hartwick	31·64	28·36	.....	24·08	.....	.....	.....	.....	....	41·75	31·46
Ithaca	.....	28·35	33·82	27·22	.....	....	39·95	35·14	26·19	31·90	31·78
Oxford	41·20	36·55	33·22	37·78	40·92	36·46	45·30	41·23	34·87	33·32	37·98
Pompey	23·84	30·30	23·21	25·54	32·79	25·28	29·84	31·38	.....	.....	31·93

TABLE VIII. *General Summary.*

PLACES.	Mean temperature.	Prevailing winds.	Av. quantity of rain.
Pompey	17 years, 42·84	17 years, NW	15 years, 29·46
Cherryvalley .	16 " 44·15	15 " W	14 " 40·83
Oxford	16 " 44·74	17 " W	17 " 36·05
Fredonia.....	15 " 48·27	15 " W	14 " 36·76
Ithaca	14 " 48·02	13 " NW	
Cortland	13 " 44·32	13 " NW	
Hartwick	12 " 45·93	12 " S	12 " 37·52
Franklin	....	12 " NW	

The foregoing tables express the average temperatures and the average quantity of rain with great accuracy, as the records were generally made by good observers. Many of the differences in temperature which appear in the tables, are due to differences in height. Many of the places are situated in vallies, and are surrounded by elevated land : some near large bodies of water, which temper the atmosphere both winter and summer ; and hence, in either case, they can not be compared with other places whose position is relatively different. The same place exhibits some anomalies in temperature. Pompey, for example, gives an average temperature of 44°·06 for ten successive years, beginning with 1826 and ending in 1835 ; for the next ten years, beginning with 1836 and ending with 1845, it is only 41°·45, a difference which is rather remarkable, considering the time during which the observations were made. Differences equal to this are rarely found to prevail in other places : for example, at Cherryvalley the average temperature for the same periods respectively are found to have been, for the first, 44°·83 ; for the second, 43°·28. If we compare the several years with each other, we shall discover that at Pompey there is less constancy or evenness of temperature than in most places. In 1826, the average was 45°·97 ; in 1836, 40°·18 ; in 1827, 43°·50 ; in 1837, 40°·02 ; in 1828, 47°·33 ; and in 1838, only 40°·27. Something of the same fitfulness may be observed as it regards the quantity of rain. The average for 1836 was 23·84 inches ; in 1837, 30·30 inches ; in 1838, 23·21 inches ; in 1840, 33·79 inches. The variation, according to these tables, amounts to about ten inches of rain. The temperature of a large extent of inhabited territory, however, is not represented. The high grounds of Allegany, and the country situated upon the ridge dividing the waters of the Genesee and the Susquehannah and Allegany rivers, must be considerably colder than Pompey. If the supposition is true, it would reduce the temperature of the district.

The vegetation of the high grounds consists of pine and hemlock, and hard wood intermixed, as represented in the woodcut on page 306. In the vallies, the hard timbers, maple, beech, oak, ash, hickory, etc. abound. The vallies are narrow, but pleasant, and furnish some fine scenery. In the cultivated vallies, the spreading branches and depressed heads of the trees indicate a greater tendency to a lateral extension ; and long branches, sometimes nearly the size of the main trunk, shoot forth luxuriantly, and afford shelter to beasts during the summer when the sun's heat is oppressive. The same species of tree can scarcely be recognized under these different circumstances. Even the hemlock, which shoots upward so magnificently in the forest, is low and depressed in the open fields. It is the finest of trees for shade ; and it is quite singular that it should not be universally admired, inasmuch as its form and color are so stately and beautiful, and it becomes a most picturesque decoration for the winter landscape, when its boughs are loaded with snow, and bend but do not break under the weight of their glittering burthen.

Plate XII. represents the sylvan vegetation of the vallies : it is a view of the scenery on the Schoharie creek, at Gilboa, at the entrance into the village from the north. The rock is the Old Red Sandstone.

6. ATLANTIC DISTRICT.

The district we have proposed under this name, is the smallest, and is surrounded by the Atlantic ocean. Its situation, its proximity to water, and the character of a part of its soil, remove this district a wide distance from the preceding ones.

Long Island, if we except the drift upon its northern slope, or that which faces the Sound, has been reclaimed from the ocean : it is based undoubtedly upon a reef of rocks, which first formed a bed whereon the waves washed up the sand, and this has continued to accumulate until the present time. The nature of the great mass of the soil, from bottom to top, is porous; and being composed of so large an amount of washed sand, the farmer is compelled to adopt a mode of cultivation more burthensome and expensive than that of any other portion of the State. The soluble manures sink into the soil, beyond the reach of the roots, in a very short period, and hence require frequent renewals.

That portion of the soil of Long Island which is largely made up of Connecticut drift, is more retentive and durable. The Hempstead plains, which occupy a high position upon the island, confirm this statement. The soil here, when washed, is merely a white beach sand, or, perhaps, in this position, a yellow sand. It is covered with a coating of black raw vegetable mould, which, when first ploughed, appears like a rich soil ; but it is quite destitute of the elements essential to fertility. It bears light crops, and produces moderately well for a season, yet soon fails without special nursing. Situated, however, as the Atlantic district is, in the immediate vicinity of a great city, the commercial metropolis of North America, it repays the labor and expense of high cultivation better than any other part of the State. It has other advantages, besides those which arise from being situated near a great city : its climate is mild, and its summer long ; hence agricultural productions may be profitably cultivated here, which, in other parts of the State, are out of the question.

The soil of a large portion of Hempstead plains, forming the ridge of the island, is mostly marine sand. The surface is mixed with black mould, in which there is a small percentage of lime in combination with an organic acid. The sand, when washed free of vegetable matter, furnishes only a trace at most of lime or magnesia. Beneath the drift on the northern slope and sides of Long Island, beds of green sand, of unknown extent, are found to exist. Members of this formation crop out on the farm of Hon. Mr. Young, of Oysterbay. They consist of a yellow clay, and the peculiar ferruginous conglomerate so common in Monmouth county, New-Jersey. The green sand so useful as a fertilizer, and which is below the ferruginous band, has not been observed.

A large proportion of the soil of Kings county is of a superior kind. Some of the largest crops of maize and wheat have been raised here. It would seem that the land is too valuable to be devoted extensively to the raising of maize and wheat. The products of the garden and orchard must necessarily, and they probably do, engage the attention of the proprietors of the soil. The best parts of the whole island will, ere long, be appropriated as country residences of the wealthy.

It is scarcely necessary to say, that in no instance is the soil of Long Island derived from rocks in place: the entire mass, therefore, is either drift or marine sand. The examination of the soils, however, has been only imperfectly performed; but enough has been observed, to prove that there is a great deficiency of the alkalies and alkaline earths. Lime and magnesia are only sparingly present in the soil of any part of the island, except that which lies along the Sound, where these materials are somewhat more abundant. The inference which follows from this fact, can not be forgotten. The means for increasing the fertility of the land are very scarce; hence nearly all the manures are brought from a distance. The stables and streets of New-York and Brooklyn contribute largely to this object.

The composition of the soils of Long Island depends upon the direction from which they came. If derived from the rocks in the valley of the Hudson river, or from the primary region bordering the Sound in the State of Connecticut, it will not differ essentially from the soil of the Taconic district, or that of the Southern Highland district. If it be the washed sand, it will belong to the highly porous and open soils, in which quartz sand is the principal constituent, and which will give, on analysis, ninety per cent of silex.

The composition of the drift, which constitutes the soil of the northern face of the island, is as follows:

Water and organic matter	6·00
Silicates	87·87
Peroxide of iron and alumina	6·25
Carbonate of lime	0·25
Magnesia	trace.
	99·50

This soil is what is called a sandy loam. The mass below is gravel, or fragments of gneiss, quartz, and mica slate. It was taken two and a half miles west of Oysterbay.

Another analysis of soil, taken in the vicinity of the preceding, gave

Water of absorption	4·00
Organic matter	3.50
Silicates	86·86
Peroxide of iron and alumina	5·75
Carbonate of lime and magnesia	trace.
	100·11

Another specimen, obtained one and a half miles west from Hicksville, gave

Water and organic matter	5·00
Silicates	87·06
Peroxide of iron	2·75
Carbonate of lime	0·37
Magnesia	0·13
Alumina	4·00
	99·01

The silicates are principally in fine angular quartz grains.

It is said that plaster is useless here. This opinion, however, is not supported by sound theoretical views, but rests upon defective observation. It is undoubtedly true that its influence is not uniformly the same upon soil at a distance from the seaboard; but here it is said to be unaffected by plaster. It is very probable that plaster is less useful than leached ashes. The ash is constituted quite differently from plaster. In addition to the bases, potash and lime, in combination with silex, it contains soluble silex; besides, the relation of ashes to moisture is more favorable to vegetation than plaster. Ashes absorb water in greater quantity, and preserve the moisture of a soil naturally disposed to part with this essential element. Vegetable composts with lime and ashes, or muck and turf, provided the expense of procuring the materials is not too great, are the most important fertilizers which can be employed in this district. It is in this form that manure will impart to the soil the greatest amount of food for plants, and will remain the longest in the surface soil.

A SERIES OF TABLES,

SHOWING THE MOST IMPORTANT METEOROLOGICAL FACTS RESPECTING THE ATLANTIC DISTRICT.

TABLE I. *Names of places, etc.*

PLACES	North Latitude	West Longitude.	Topographical remarks.
Flatbush ...	40°37′	73°58′	Near the western extremity of Long Island, and situated on an inclined plane descending to the ocean. 40 feet above tide.
Jamaica.. .	40 41	73 50	About 100 feet above tide.
Clinton ...	41 00	79 19	Eastern part of Long Island. 16 feet above tide,

TABLE II. *Mean temperature for each month in* 1845.

PLACES.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual mean.	Highest and lowest degree.		Annual range.	Greatest monthly range.
Flatbush	35·05	32·65	43·37	50·51	59·03	68·84	75·37	74·42	64·61	56·34	47·11	29·73	53·09	95	— 7	88	51
Jamaica	32·55	30·42	39·57	45·01	55·91	65·32	71·43	72·89	62·37	53.81	42·12	25·19	49·71	99	— 2	97	60

TABLE III. *Prevailing winds in each month for* 1845.

PLACES.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Flatbush	NW	NW	SW	NE & NW	SW	SW	SW	SE	NW	SW	SW	W & NW
Jamaica	NW	NW	NW	SW	SW	SW	NW & SW	SW	NW	NW	NW	NW

TABLE IV. *Rain gage for each month.*

PLACES.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.	Driest month.	Wettest month.
Flatbush .	3·84	4·45	2·50	1.04	1·55	3·36	1·67	3·27	2·65	1·92	3·08	2·81	32·14	April	February.
Jamaica..	2·19	3·52	1·85	1·28	1·20	4·41	3·56	3·46	2·98	2·72	3·42	3·21	33·71	May.	June.

TABLE V. *Comparative view of the average temperature for ten years, from 1826 to 1835, both inclusive.*

PLACES.	1826.	1827.	1828.	1829.	1830.	1831.	1832.	1833.	1834.	1835.	Average.
Flatbush	53·96	51·63	53·68	50·50	52·53	51·28	51·54	51·83	51·36	49·49	51·78
Jamaica	52·19	50·95	52·05	48·51	51·05	49·51	49·20	51·84	50·10	46·84	50·22
Oysterbay	.....	.....	.....	.....	.....	.....	.....	.....	51·85	.....	51·85
Clinton	.....	49·31	51·29	48·14	49·82	48·78	48·00	49·09	49·38	46·60	49·06

TABLE VI. *Mean temperature for the last ten years.*

PLACES.	1836.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	Average.
Flatbush	47·73	49·39	50·49	51·33	51·34	51·11	52·05	51·15	51·81	53·09	50·95
Jamaica	46·52	47·23	48·32	49·31	44·91	48·51	48·37	48·07	49·02	49·71	48·50
Clinton	46·92	46·20	46·99	49·25	49·46	49·65	50·90	48·80	.....	.....	48·52
Oysterbay	.....	49·77	.....	.....	.....	.....	.....	.....	.....	.....	49·77

TABLE VII. *Quantity of rain for the last ten years.*

PLACES.	1836.	1837.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	Average.
Flatbush	43·89	34·66	41·11	42·90	35·93	52·12	47·58	50·19	39·07	32·14	41·96
Jamaica......	36·48	32·13	33·70	33·44	35·47	44·57	41·59	33·56	43·72	33·71	36·85
Clinton	35·50	34·26	28·07	46·39	43·32	43·62	33·10	.....	.....	.....	37·75

TABLE VIII. *General Summary.*

PLACES.	Mean temperature.	Prevailing winds.	Av. quantity of rain.
Flatbush	20 years, 51·36	20 years, NW	20 years, 43·52
Jamaica	20 " 49·36	20 " NW	20 " 39·44
Clinton	17 " 48·74	17 " NW	16 " 38·59

VIII. A COMPARISON OF THE SOILS OF THE AGRICULTURAL DISTRICTS, UPON THE BASIS OF PRODUCTIVENESS, AND THE QUALITY OF THE CROPS.

The comparative view which we design now to present to the public, rests, as will be perceived, upon a basis which will furnish data whereby we shall be enabled to judge of the relative value of the different districts for the kinds of husbandry commonly pursued in the latitude of New-York. This basis we may regard as entirely independent of the results of analysis. It ought, however, to bring us to the same result. The two methods should agree, and no doubt will do so, provided our data are sufficient. It is not supposed that a few isolated comparisons will be sufficient for our purpose: the data must be derived from entire districts. It is like those calculations which regard the duration of life, the proportions of the sexes, etc., where communities or nations are concerned. It is true, that in an extent of country no larger than the State of New-York, local causes may give one place a preponderance for certain productions over some other part of the State, which by nature is better adapted to their growth. Thus, in the vicinity of the city of New-York, some of the necessaries of life may be cultivated with profit, though the actual expense there may be greater than at the distance of one hundred miles. We are to bear in mind, therefore, that the great cities, or, in other words, the markets, must control to a certain extent many kinds of husbandry. But after all the deductions proper from considerations of this nature, it will be found that staple productions are not controlled by any one market: the general wants of the species control their cultivation and growth.

It will be necessary to ascertain the average production of the different crops for the whole State, and then the average of the same crops for the different districts. In connexion with this comparison, it will be interesting to state the premium crops, by which we shall know the present capabilities of lands in the different parts of the State; and could we ascertain the amount of the crops raised from the early settlement of the country, down to the present time, we should be able to calculate the loss which the soil has sustained under cultivation, as well as the progress which the husbandry of the State has made since its first settlement.

The first product which we propose to consider, is wheat, a product which must ever constitute one of the greatest and most important necessaries of life. The whole quantity of wheat raised in New-York, in 1844-5, was 13,391,770 bushels. This amount was harvested from 958,233 acres; the average product, therefore, for the whole State, was nearly 14 bushels per acre. We may now compare the product of the districts. In this comparison we propose to leave out the Highland district, or rather to merge it in the Taconic or Eastern district.

Commencing then with the lowest geological system, which is geographically the most eastern, we find that the several counties taken separately yielded as follows: Westchester an average of 9 bushels per acre, Dutchess 5, Columbia 6, Rensselaer 8, and Washington

12. The average for the whole district, therefore, is only 8 bushels per acre. It is proper to state, that this low average may not be independent of causes connected with the capacity of the soil to produce wheat. It is well known that the wheat fly has committed more extensive ravages in this than in the western part of the State; still, it is not to be supposed that to the fly alone is to be attributed the small average. The crop is more liable to other accidents, to rust, and shrinkage, than in the western counties; accidents depending in a great measure on the adaptedness of this soil to this crop.

The territory forming the Taconic district lies upon the eastern side of the Hudson river. If we now extend our observations to the district which has been called the Hudson and Mohawk district, we shall embrace a large extent of country differing but little from the preceding.

Albany county raised 44,149 bushels upon 6112 acres, which gives an average of $7\frac{1}{2}$ bushels per acre.
Fulton county raised 17,118 bushels upon 1618 acres, thus giving an average of $11\frac{1}{2}$ bushels per acre.
Rockland county raised 1705 bushels upon 194 acres, the average of which is 9 bushels per acre.
Saratoga county raised 104,660 bushels upon 9745 acres, the average of which is 10 bushels.
Schenectady county raised 19,754 bushels upon 1918 acres, whose average is $10\frac{1}{4}$ bushels.

The average of these counties, mostly embraced in the Hudson and Mohawk district, is a little over $9\frac{3}{5}$ bushels. Albany county raises only a small crop of wheat; the lands within 10 or 12 miles of Albany city being cultivated for the more marketable crops, such as hay, corn, oats, and garden vegetables.

If Oneida and Herkimer counties were added to the foreging calculations, the average for the wheat crop would be increased, as the average for these two counties together is $13\frac{1}{4}$ bushels per acre. The reason why these counties are not added, is that their territories extend into the Wheat district proper, being underlaid by the shales of the Clinton group, and our data do not permit us to determine upon what parts of these counties the greatest number of acres of wheat were raised.

The wheat crop of the western and central counties may now pass under our examination.

Cayuga county, in which was raised, in 1845, 652,896 bushels. The number of acres upon which this amount of wheat was harvested was 41,783, which gives an average of 16 bushels per acre.
Erie county raised 251,784 bushels upon 20,433 acres, which is an average of only 12 bushels per acre.
Genesee county raised 695,107 bushels upon 42,960 acres, which is an average of $16\frac{1}{2}$ bushels per acre.
Livingston county raised 821,702 bushels upon 52,047 acres, averaging 16 bushels.
Madison county raised 190,361 bushels upon 13,477 acres, the average of 14 bushels per acre.
Monroe county raised 1,338,585 upon 68,382 acres, making an average of $19\frac{1}{2}$ bushels per acre.
Niagara county raised 713,318 bushels upon 39,521 acres, equalling 18 bushels per acre.
Onondaga county raised 918,616 bushels upon 57,924 acres, giving 16 bushels per acre.
Orleans county raised 692,127 bushels upon 38,731 acres, which gives an average of 18 bushels.
Seneca county raised 483,773 upon 32,698 acres, the average of which is 15 bushels per acre.
Wayne county raised 587,817 bushels upon 41,041 acres, giving an average of $14\frac{1}{2}$ bushels.
Wyoming county raised 331,111 upon 22,564 acres, giving an average of 15 bushels per acre.

The average of the foregoing twelve counties amounts to 15½ bushels per acre. In several of these counties, the average is reduced considerably, by the crop being raised upon a soil derived from the rocks above the Marcellus shales, or underlaid by the lower and more sandy soil of the Medina sandstone.

In the Southern district, the results by the census returns are as follows:

Allegany county raised 260,190 bushels upon 23,600 acres, thus giving an average of 11½ bushels.
Broome county raised 81,388 bushels upon 7204 acres, whose average is 11½ bushels per acre.
Cattaraugus county raised 177,927 bushels upon 15,331 acres; the average is 12 bushels.
Chemung county raised 180,095 bushels upon 15,365 acres, an average of 12 bushels per acre.
Chenango county raised 104,562 upon 8313 acres, giving an average of 13 bushels per acre.
Cortland county raised 96,852 upon 8111 acres, the average being 12 bushels per acre.
Otsego county raised 109,551 bushels upon 8733 acres, giving an average of 13 bushels per acre.
Sullivan county raised 3252 bushels upon 310 acres, giving an average of 10 bushels per acre.
Yates county raised 403,069 bushels upon 20,447 acres, giving an average of 14 bushels per acre.

The average of the nine foregoing counties is 12 and a fraction bushels per acre.

The Atlantic district gives the following result:

Kings county raised 26,992 bushels upon 1411 acres, giving the average of 19 bushels per acre.
Queens county raised 99,374 upon 8702 acres, giving an average of 12 bushels per acre.
Suffolk county raised 77,423 bushels upon 6611 acres, giving an average of 12 bushels per acre.

The average of the three counties is 14 bushels per acre.

The average of the	Taconic district is	8 bushels per acre.
	Hudson and Mohawk district	9¾ "
	Western and Central district	15⅓ "
	Southern district	12 "
	Atlantic district	14 "

The average derived from the above estimates is less than that of the State. The loss is to be set down to the Hudson and Mohawk district.

The maize crop gives a result somewhat different. Pursuing a plan of estimates similar to that respecting the wheat crop, we shall find that the Taconic district, which is so poor in wheat, is quite as productive in maize as the Central and Western districts. This deficient return in wheat is therefore not due to poverty of the soil, but to its peculiar adaptedness for maize.

TABLE SHOWING THE QUANTITY OF MAIZE AND OATS HARVESTED IN THE SEVERAL DISTRICTS, IN THE YEAR 1845.

I. Maize.

COUNTIES.	Acres planted.	Bushels raised.	Average.
1. *Taconic district*			
Westchester,	15,593	498,019	32 bushels.
Washington,	19,766	471,756	25½ "
Rensselaer .	17,942	403,548	22½ "
Dutchess ...	32,391	814,153	25 "
Columbia...	28,350	526,629	18½ "
Orange*	18,442	603,167	32 "
2. *Mohawk and Hudson district.*			
Albany.....	10,251	208,254	20 bushels.
Fulton	5,813	105,124	20 "
Herkimer ..	8,073	180,340	22 "
Jefferson† ..	17,432	467,229	27 "
Lewis	2,291	53,180	25 "
Saratoga....	5,279	103,729	20 "
Schenectady	4,786	85,173	18 "
Montgomery	9,455	187,700	20 "
3. *Central and Western district.*			
Cayuga.....	16,765	479,151	24 bushels.
Erie	10,530	238,295	22½ "
Genesee ...	8,298	225,615	25 "
Livingston..	9,922	257,346	25 "
Madison ...	9,279	230,781	25 "
Monroe	15,270	453,463	30 "
Niagara	6,824	188,166	29 "
Onondaga ..	19,688	516,496	27 "
Ontario	12,936	357,747	29 "
Orleans	7,783	213,702	30 "
Seneca	12,341	304,403	25 "
4. *Southern district.*			
Allegany ...	4,845	101,140	21 bushels.
Broome	6,611	172,713	26 "
Chautauque.	12,247	313,121	25 "
Chemung...	6,461	177,965	27 "
Chenango ..	8,807	241,205	27 "
Cortland ...	5,632	123,186	24 "
Delaware...	3,732	85,128	23 "
Otsego	9,981	201,031	20 "
Steuben ...	8,976	194,063	21 "
Sullivan....	4,587	62,362	15 "
Tioga	6,307	168,160	27 "
Yates	6,122	135,999	22 "
5. *Atlantic district.*			
Kings	3,241	124,688	38½ bush.
Queens	17,221	438,661	25 "
Suffolk	15,878	501,938	34 "

Average crops of MAIZE, *for the year* 1845.

Taconic district	26	bushels	per acre
Hudson and Mohawk district....	21¼	"	"
Central and Western district	26	"	"
Southern district	23	"	"
Atlantic district	32¼	"	"

* Orange county is annexed to this district, as being traversed by taconic slate.
† The geological formations in Clinton and Jefferson are identical.

II. Oats.

COUNTIES.	Acres sowed.	Bushels raised.	Average.
1. *Taconic district.*			
Westchester,	11,963	316,156	26 bushels.
Rensselaer .	26,942	763,844	29 "
Columbia...	42,379	1,093,850	27½ "
Dutchess ...	40,531	1,283,718	30 "
Washington,	25,525	593,423	23 "
Orange	14,646	417,388	28½ "
2. *Mohawk and Hudson district.*			
Albany.....	28,921	624,038	22 bushels.
Fulton	14,249	287,221	20 "
Herkimer ..	27,012	690,413	25 "
Jefferson ...	26,462	709,232	27 "
Montgomery	34,187	717,212	21 "
Saratoga ...	27,373	620,395	23 "
Schenectady	14,640	254,455	18½ "
Ulster	17,607	429,713	25 "
Clinton	9,969	268,258	27 "
3. *Central and Western district.*			
Cayuga.....	21,382	652,281	30½ bush.
Erie	27,313	637,513	23½ "
Genesee ...	12,308	406,594	23 "
Livingston..	11,616	351,233	30 "
Madison ...	18,510	517,789	28 "
Monroe	16,832	538,063	32 "
Niagara	10,098	292,099	29 "
Onondaga ..	26,506	829,002	31 "
Ontario	16,461	533,062	32 "
Orleans	8,186	236,743	29½ "
Seneca.....	8,224	292,397	35½ "
Wayne	17,522	476,422	28 "
4. *Southern district.*			
Allegany ...	22,274	503,134	22½ bush.
Broome	13,945	331,425	24 "
Cattaraugus,	19,095	459,770	21 "
Chemung...	11,604	287,146	26 "
Chenango ..	21,430	597,508	28 "
Cortland ...	15,134	400,342	26½ "
Delaware ..	28,950	648,982	22½ "
Otsego	46,145	1,004,541	22 "
Steuben ...	24,356	635,304	26 "
Sullivan ...	6,457	150,300	25 "
Tioga	10,535	265,922	26 "
Tompkins ..	20,385	528,763	26 "
Yates	8,108	224,673	28 "
5. *Atlantic district.*			
Kings	1,799	64,786	36 bushels.
Queens	12,160	324,218	27 "
Richmond ..	1,009	27,704	27 "
Suffolk	10,583	278,820	27 "

Average crops of OATS, *for the year* 1845.

Taconic district	27⅓	bushels	per acre.
Hudson and Mohawk district ..	23	"	"
Central and Western district ..	29	"	"
Southern district	25	"	"
Atlantic district	29¼	"	"

IX. OBSERVATIONS ON THE PRECEDING ANALYSES.

Having stated the foregoing results respecting the soils of New-York, which we have obtained by analysis, we deem this the proper place for introducing a few explanatory remarks upon the subject which has so long occupied our attention.

The objects which we have had in view, were to obtain a general expression respecting the composition of the soils in the districts which we have referred to so often; and to arrive at data by which not only the capabilities of the soils might be ascertained, but the reason why the soils of one district were so well adapted to the cultivation of wheat, and another to that of maize. Other objects of importance are still before us. What are the deficiencies in the soil of a given district, and how may these deficiencies be supplied? Observation had taught the most discerning agriculturists that their soils had undergone some remarkable change, in consequence of which important crops, which had once been successfully and profitably grown, had ceased to be so. The reason why such a change had taken place, became an important problem to solve.

Wheat was once the great staple production of the Mohawk and Hudson valley; but this crop has ceased to be profitable, unless it be for family consumption: it is not an article which goes extensively into market. What is the cause of the change? It can not be due to atmospheric influences: the seasons succeed each as in the days when the Dutch first lighted their fires, and slept safely under the guns of Fort Orange. The snows and rains bring down ammonia and carbonic acid as formerly, and thus furnish to the soil the same elements. Without doubt we may say, then, that the altered conditions which influence the wheat crop are to be sought for in the soil. This view of the question, however, could not be determined directly. If the exact constitution of the soil of this part of the State had been determined at the period alluded to, we have no doubt of the truth of the position that a full analysis of the same soil, at the present time, would detect the essential losses it has sustained in the successive croppings to which it has been subjected. But we have no analyses made thus early, and hence are constrained to pursue an indirect route. We may determine the constituents essential to a wheat soil, or the constitution of a soil when this crop is not only productive, but free from such accidents as rust and shrinkage. With these objects before us, we engaged in the foregoing analyses. They have been conducted with care, and, so far as they go, may be relied upon. The foregoing analyses, however, give in general the mineral constituents, or those which are comparatively free and soluble: they do not determine the actual capabilities of the soils, nor the exact proportion in which the elements exist. Considering that it was an object of sufficient importance to determine the amount of the elements as they exist, both in a free and combined state, we have engaged in a more determinate and exact method, which it is proper we should state in detail in this place.

The analyses were conducted through two operations. The first was precisely that by which we obtained the results already stated. The silicates, alumina and iron, lime and magnesia, were severally obtained by the usual methods. To secure exactness, the double filters were always well washed, dried, burnt and weighed. We then tested for phosphates, by redissolving the alumina and iron in chlorohydric acid : the soluble silex was separated by filters, and, if in a decidedly appreciable quantity, it was weighed. The solution being freed from silica, was exactly neutralized by caustic ammonia, and the phosphates, if any existed, were thrown down by a solution of acetate of potash. Sometimes the phosphate of alumina and phosphate of the peroxide of iron did not immediately appear, but, in the course of five or six hours, it would become perceptible, and in twenty-four hours it subsided. In some cases its presence would be sensible, but its quantity so small that it did not appear of sufficient importance to filter and weigh. The iron and alumina were not separated.

Having subjected the alumina and iron to the above test for phosphates, we then took up the farther examination of the silicates obtained in the first operation. This was, in the first place, fused in a platina crucible, with three times its weight of carbonate of soda. The fused mass was then dissolved out by boiling water acidulated with hydrochloric acid, evaporated to dryness, and then redissolved ; when it was subjected to the same course of treatment, for alumina, iron, lime, magnesia, potash and soda.

By this treatment, we supposed the capability of the soil would be determined. The advantages of this double process consist in obtaining first the elements which are more immediately available to the crops ; and, in the second process, we learn the amount of the elements which are more securely locked up by the silica for future use. Both operations give the capabilities of the soil. In the second operation, phosphates are never obtained, but lime, alumina, iron and some magnesia usually ; and in a few instances, where the soil contained much matter from the primary rocks, a greater amount of lime was obtained than by the first operation : the amount of magnesia is much less also. The phosphates of the soil which have been derived in the last place from animal or vegetable origin, may be expected to be easily dissolved ; and it is quite doubtful whether any exists in any soil, which may not be dissolved and obtained by the first operation. They probably exist in fine particles in the soil as phosphate of lime and alumina, and, if so, are almost as soluble as the phosphates contained in bones. The phosphates, then, so far as they exist, are always soluble, and never locked up in combination with an acid, such as will not yield to the action of the weak organic acids, which are formed in the soils by peculiar changes that take place in woody fibre and other vegetable products.

The process by which soluble silica was obtained, we deem highly important. We believe we do not err when we state that silica is an element equally important in vegetation with the phosphates, or the potash and alkaline earths. It is a mistaken notion, if it exists, that fertility is due to any one element; that a good crop of corn can be raised, provided the phosphates, or any other one of the necessary elements, are in sufficient quantity. If any thing, silica plays a more important part in vegetation than any other element, notwithstanding it is so inert to our senses. It exists, it is true, in greater proportion in those parts of grain which are rarely consumed by man, as the straw of the cereals; yet the seed, the part used by us as food, is perfected only when the silica of the straw is in due proportion. Hence it may be, that, in many soils, the very want of soluble silica is the only reason why the cereals are not raised and cultivated successfully. If so, it is at once suggested that here is a case to which Liebig's manures would be specially adapted.

Silica is rendered soluble by the action of potash and the alkalies: if it is fused with them, it becomes perfectly soluble in water. We may suppose, however, that the mere addition of ashes to a soil wanting in soluble silica, would secure the attainment of the object sought: they would dissolve, or, in other words, enter into combination with the silica of the soil, and thus supply the great desideratum.

If we look carefully over the many analyses of grains and other vegetable products, we can scarcely fail to be convinced that none of the elements which appear in the foregoing analyses are unimportant: they are wanted by different vegetables in different proportions; but all are wanted, and all are consumed. It may be that the quantity in which some of them appear is inconsiderable, and, to a superficial observer, such an element may not appear to be essential; but this opinion is inadmissible, and we are obliged to accede to the view which maintains that a minute proportion of one element is as essential to the composition of a grain in its perfect state, as the more ample abundance of another.

In making our analyses, the amount of potash and soda should have been determined more frequently, had time permitted. It is true, many of the analyses might have been omitted, and the process in the remaining instances carried to its ultimatum. In explanation of our course of proceeding, it seemed quite desirable to increase the number even of partial analyses. We had very clearly six districts, the character of whose soils were to be determined; and this required many analyses, carried at least so far as to determine the amount of lime and magnesia, two great elements in the constitution of soils. Another reason for the omission in regard to soda and potash, is that we were not fully convinced of the utility of the analyses we were engaged in. A variety of opinions prevailed, and do still prevail, in regard to this part of the work; and hence in consequence of the doubt which brooded over us, we did not commence in earnest at a period sufficiently early to enable us to execute what we now wish; and even now we shall not be disappointed if a contrariety of opinion exists as to the usefulness of our work. Some valuable facts have been elicited by the questionings we have put to the soils of the several districts; and we believe we have prepared the way for more, or for an advance in this mode of procedure.

We lay more stress, however, upon the matter, when applied to the soils of this State, than when applied to those of New-England. The soils of this State are far more uniform in their composition; and hence a single analysis is worth more, for the purpose of determining what the soil is for a wide extent of territory, than elsewhere. This is quite manifest in our analysis of the soils of the Wheat and Taconic districts: they differ, and those differences can not be accounted for by supposing that they are due to local accidents. Then again there is a similarity in the soils of the same geological regions, and this similarity is not due to accident, but to those general influences which have prevailed and operated over a widely extended territory.

It is this uniformity in the composition of the New-York soils, which has led us on from step to step, and kept us at work in this part of the survey; and as this fact could not be known at the outset, but must develop itself only in the progress of the work, it will appear as a reason why some things have been omitted and others performed.

We may now proceed to state in detail those more thorough analyses, by which those interested will be able to compare the composition of the soils of the several districts with each other, and perceive the foundation upon which the pursuits in husbandry receive their special impulses; for the husbandry of a country can go only in certain channels with much profit. Especially is this the case with the direct products of the soil; and the impulse which starts it, and impels it forward in this channel, is derived mainly from the composition of the soil. The local influence of small markets affects merely the minor products, or those which are derived from high garden culture.

We shall first lay before our readers the constitution of the soil of the Taconic district. By reference to the map, the extent of this district will be seen; but for a more perfect understanding of its character, we must refer to the geological structure, and the peculiar influence which diluvial action has exerted on this territory.

Our attention has been directed to the soils of Rensselaer and Washington counties. The first analysis is of a soil remarkable for the production of maize, and which has been cultivated thirty or forty years. It is in the south part of Hoosic, on high ground, and underlaid by the taconic slate. The analysis was made upon a dry soil, which lost on drying at 300°, 4·40, which is set down as water, but not reckoned as an element.

ANALYSIS.

	First process.	Second process.
Organic matter	9·31	00·00
Silicates and silex	77·00	70·87
Peroxide of iron and alumina	11·58	4·50
Lime	1·31	1·63
Magnesia	0·25	0·00
	99·45	77·00

Soluble silex	2·12
Phosphates	1·25
	3·37

This soil is remarkable for its amount of vegetable matter, of soluble silex and the phosphates, especially when taken in connexion with the fact that it has been cultivated so many years for maize, having been distinguished for its steady and abundant yield of this exhausting crop. The element which seems to have been removed by cultivation, is magnesia.

Soil near Hoosic corners.

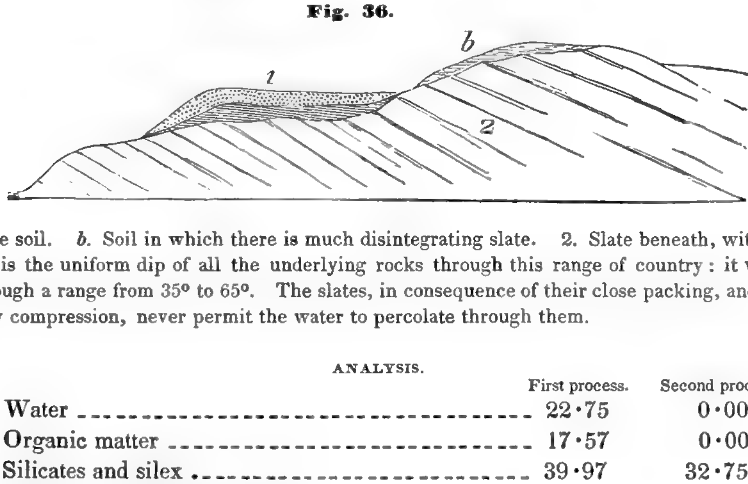
This soil was not fused with soda.

ANALYSIS.

Water	4·25
Organic matter	12·69
Silicates	69·78
Peroxide of iron	5·75
Alumina	3·92
Phosphate of alumina	1·15
Carbonate of lime	1·16
Magnesia	1·30
	100·00

The succeeding analysis was made of a soil which has never been manured, and has been in grass thirty years: it has, however, received the wash of a higher piece of ground. It is upon the same formation as the preceding. The land is owned and cultivated by Mr. L. C. Ball, of Hoosic falls, three miles north from Hoosic corners.

Fig. 36.



1. Position of the soil. *b.* Soil in which there is much disintegrating slate. 2. Slate beneath, with a southeasterly dip, which is the uniform dip of all the underlying rocks through this range of country: it varies in amount, passing through a range from 35° to 65°. The slates, in consequence of their close packing, and which has been increased by compression, never permit the water to percolate through them.

ANALYSIS.

	First process.	Second process.
Water	22·75	0·00
Organic matter	17·57	0·00
Silicates and silex	39·97	32·75
Peroxide of iron and alumina	16·93	6·00
Sulphate of lime	1·50	0·00
Carbonate of lime	0·73	0·00
Lime in combination with silica	0·00	1·25
Magnesia	0·30	0·00
	99·75	40·00

We have usually found sulphate of lime in the soils of the Taconic district.

ANALYSIS BY WATER.

Soluble silica in the above	0·75
Phosphates	0·20
Sulphate of lime	1·50
Magnesia	0·12
Alumina and iron	3·20
	4·82

It is probable that a portion of the percentage set down as alumina and iron, is phosphoric acid, though not tested.

The two following analyses were conducted by acid alone. The first is of a soil obtained from a slaty hill-side with a western exposure, which has been cleared forty years, and manured occasionally, but by no means highly: owned by Mr. L. C. Ball, Hoosic falls. The second analysis is of a more slaty specimen of soil, procured three miles east from the former locality, near the Bennington line.

FIRST ANALYSIS.

Water	8·64
Organic matter	5·94
Silicates	77·74
Peroxide of iron and alumina	3·65
Carbonate of lime	3·82
Magnesia	0·21
Phosphates	0·05
	100·05

SECOND ANALYSIS.

Water	4·60
Organic matter	6·72
Silicates	74·87
Peroxide of iron and alumina	12·37
Carbonate of lime	0·18
Magnesia	0·12
Phosphates	0·20
Soluble silex	0·05
	99·11

Analysis of soil taken from the farm of Mr. E. Long of Cambridge, Washington county. This farm belongs to the Checkered House (so called). Soil treated by acid and alkali.

	First process.	Second process.
Water	9·25	0·00
Organic matter	8·25	0.00
Silicates and silica	67·88	66·65
Peroxide of iron and alumina	10·31	1·25
Lime	3·56	0·00
Magnesia	0·75	0·00
	100·00	67·90

In this specimen, the lime was in a soluble state, or rather it was all in the state of a carbonate, and not in combination with silica, as in some of the preceding instances. The same remark holds good in respect to the alumina and iron, as only 1·25 grains was obtained by thorough decomposition of the silicates by soda; whereas the first process yielded 10·31 grains. This soil contained soluble silex 0·26 grains, and a trace of the phosphates. The farm has been cultivated probably ever since the settlement of Washington county. The Checkered House, as a place of entertainment, was well known to the oldest inhabitants on the western slope of the Green mountains.

Soil from Salem, Washington county.

ANALYSIS.

	First process.	Second process.
Organic matter	10·60	0·00
Silica and silicates	67·24	66·12
Peroxide of iron and alumina	20·00	0.75
Carbonate of lime	1·06	0·00
Lime in combination with silica	0·00	0·25
Magnesia	0·63	0·12
Magnesia in combination with silica	0·00	0·00
	99·53	67·24

Phosphates .... 0·05

This sample of soil is remarkable for the large quantity of peroxide of alumina and iron. It is an excellent soil for maize, and is owned by the Hon. Mr. Blair of Salem.

A soil from the eastern part of Salem.

ANALYSIS.

	First process.	Second process.
Organic matter	5·80	0·00
Silica and silicates	82·10	74·35
Peroxide of iron and alumina (free)	9·21	0·00
do (combined)	0·00	6·50
Carbonate of lime (free)	1·06	0·00
do (combined)	0·00	1·25
Carbonate of magnesia (free)	0·81	0·00
do (combined)	0·00	trace.
	99·58	82·10

Phosphates .... a trace.
Soluble silex .... 0·50

The above soil contains a very large quantity of the silicates of alumina and iron. The trace of phosphates was large, but not weighed. The soils of the eastern range of hills in Salem, and onwards north or south, are all good lands, and the elements seem to be combined in their proper proportion for grass and the cereals.

Analysis of soil from Glensfalls, Warren county.

This soil is sandy, and consists of an extension of the lands passing through Albany, Schenectady and Saratoga counties.

	First process.	Second process.
Organic matter	6·60	0·60
Silica and silicates	86·94	69·44
Peroxide of iron and alumina (free)	4·25	0·00
do (combined)	0·00	15·00
Carbonate of lime	1·50	0·00
Lime combined	0·00	2·50
Magnesia (free)	trace.	0·00
do (combined)	0·00	trace.
	99·35	86·94

Phosphates	0·31
Soluble silica	a large trace.

This soil is still more remarkable for the great amount of combined alumina, iron and lime; and its analysis explains in part the fact why this sandy range of country is productive and durable, yielding at least moderate or respectable crops of maize for many years in succession. It contains more mineral food for plants than an inspection of the soil would lead us to suspect.

Analysis of peat from Hoosic falls.

From a farm owned and cultivated by Mr. E. Ball.

Organic matter	56·00
Silica	26·00
Alumina and iron	8·00
Carbonate of lime	9·00
Magnesia	1·00
	100·00
Amount soluble in water.	
Carbonate (crenate)	1·82
Magnesia	0·34
	2·16

The above specimen of peat is probably one of the most valuable manures which the farmers of the neighborhood can employ, containing a large quantity of the silicates (not sand), in a state ready to be used by plants.

It seems, from the several analyses which we have made of the peats from different parts of the country, that a great difference of composition exists; some consisting of organic matter, with a very small amount of inorganic; while others, as in the instance above, contain a large amount of inorganic matter, a considerable proportion of which is in combination with organic acids. The latter kind is by far the most valuable: hence it is well to examine the peats by chemical tests. If these peats are burned, they are less valuable as manures: there is a loss of organic matter, and the silica becomes insoluble in consequence of its having been ignited.

Analysis of a slaty limestone intercalated with the taconic slate.

From the farm of Mr. E. Ball.

Silex	11·50
Peroxide of iron and alumina	6·36
Carbonate of lime	82·14
	100·00

Analysis of a hard blue limestone from Hoosic (Sparry limestone).

Silex	7·40
Alumina and iron	1·60
Carbonate of lime	91·00
	100·00

These limestones are sufficiently pure for agricultural uses. Their examination was undertaken for the purpose of ascertaining whether they were magnesian, and suitable for hydraulic lime; but neither of them contain any magnesia.

From the foregoing examples of analysis of the soils of the Taconic district, taken in connection with those previously given (page 243 – 249), we may learn the general composition of its soils. The later analyses were of soils which have been for many years under cultivation. In these examples, it will be observed that magnesia is diminished; inasmuch as in all instances where we have analyzed uncultivated soils, it exists in much greater quantity. These soils have been subjected to rigorous treatment, in consequence of the kind of crops which have been taken from them, particularly in being planted with indian corn or maize, which, as is well known, consumes a large proportion of the phosphate of magnesia. These lands, as analysis has abundantly shown, are well fitted to this crop; inasmuch as in every analysis where the phosphates have been sought for, they have been found. The same opinion would be formed, too, by an inspection of the crop itself in autumn, when the exhibition of the well-formed and well-filled ears shows the inherent adaptedness of the soil to the crop. It is for these reasons that we have laid some stress upon the name we have given to this formation, namely, the *Maize district.* We must observe, however, that this is not the only region which produces maize of a superior excellence in consequence of the composition of its soil. My earliest examinations of the soils of the different districts led me to adopt the opinion that the Taconic district was, as a whole, the best adapted to the growth of maize; but I have since found a soil in Western New-York, at a certain height above the Wheat region, which is quite as well adapted to the growth of this grain, having about the same proportion of phosphates as the soils of the Taconic district. I shall speak of this region in its proper place.

We shall now proceed to give a statement of the analysis of several soils taken from Christian-hollow* and its vicinity, which has been, and still is, noted for its wheat-growing capacity. The first specimen was selected from the farm of Mr. Palmer, in the southeast part of the town of Lafayette, on the west side of Christian-hollow. It was taken from the third terrace (fig. 37, *d*).

Fig. 37.

a. South end of Christian-hollow, and first terrace. *b.* Second terrace. *d.* Third terrace. Below *a* is the Marcellus slate and Hamilton slate or shale; and above *d*, from which the soil was taken, is the Tully limestone. The rocks of this section are, for short distances, horizontal.

It was cleared in 1830, and has never been manured. It was cropped for ten years, and has steadily yielded forty bushels of wheat to the acre.

ANALYSIS.

	First process.	Second process.
Water	11·2212	0·0000
Organic matter	7·8490	0·0000
Silica and silicates	72·8296	66·6796
Peroxide of iron and alumina	6·7483	0·0000
Combined alumina, etc.	0·0000	5·2148
Carbonate of lime	1·7436	0·0000
Combined lime	0·0000	0·7500
Magnesia	0·3086	0·0000
	100·7003	72·6344

Soluble silica 0·1852

Phosphates not appreciable in one hundred grains.

* Christian-hollow is a north and south valley in Onondaga county, nearly surrounded by hills from two hundred to six hundred feet high. It was originally settled by a thievish population; and hence the name *Christian-hollow*, given on the principle of contrast.

ANALYSIS OF THE SUBSOIL.

	First process.	Second process.
Water	13·5151	0·0000
Organic matter	8·3680	0·0000
Silica and silicates	62·41915	57·8715
Peroxide of iron and alumina	14·41117	0·0000
The same combined	0·0000	4·0600
Carbonate of lime	0·7715	0·0000
Lime combined	0·0000	0·5000
Magnesia (free)	0·2315	0·0000
do (combined)	0·0000	0·0600
	99·8818	62·4315
Soluble silica	0·0925	

The examination of the surface soil for soluble silica and soluble matter, without ignition, gave 20·1207 of soluble matter, and soluble silica 0·1852. About double the quantity is obtained when the soil is not raised to a red heat: this we have found to be a constant result. These soils lie upon the upper part of the Marcellus slate; and upon the surface there are a good many boulders or fragments of rock derived from the Chemung group, and also some large boulders of blue limestone scattered over the farm.

The following is an analysis of soil from another piece of land of the same farm, which was cleared in 1816, and has been cropped most of the time since. Wheat has been grown on the land for five years in succession: average crop, thirty bushels per acre. It is now down (1846) to grass. The crops have never been poor.

ANALYSIS.

Water	10·0967
Organic matter	14·4271
Silicates	71·1632
Peroxide of iron and alumina	3·2712
Carbonate of lime	0·9721
Magnesia	0·0308
Soluble silica	0·0308
	99·9919

ANALYSIS OF THE SUBSOIL.

Water	2·0089
Organic matter	4·2433
Silicates	86·9623
Peroxide of iron and alumina	4·9942
Carbonate of lime	0·3066
Magnesia	0·0617
Soluble silica	trace.
	98·5790

Phosphates not appreciable in 100 grains.

The quantity of organic matter is much less in the subsoil; and the result of this analysis, as it respects the lime and magnesia, is precisely as has occurred in many instances before: there is more at the surface than below, contrary to what we had supposed before we engaged in the analysis. It appears from the analysis of the surface soil, that it has felt the effects of constant cropping, and this is what we should expect. The deep soils, in reality, are much the same two feet below the surface, as at the surface, except in the amount of organic matter and water.

Analysis of soil in Christian-hollow.

Situated below a deposit of tufa: uncultivated or new land. Soil dried at 212° Fahr.

	First process.	Second process.
Water	11·34	0·00
Organic matter	6·71	0·00
Silica and silicates	72·85	69·07
Peroxide of iron and alumina (free)	7·50	0·00
do (combined)	0·00	3·58
Carbonate of lime (free)	0·40	0·00
do (combined)	0·00	0·55
Magnesia (free)	0·24	0·00
do (combined)	0·00	0·29
Soluble silica	0·30	0·00
	99·07	73·49

ANALYSIS OF SUBSOIL.

Water	12·75
Organic matter	6·94
Silicates	65·06
Peroxide of iron and alumina	11·94
Carbonate of lime	1·12
Magnesia	none
Soluble silica	0·02
	97·83

Surface soil from the farm of D. Spaulding.

Receives the wash from a hill situated to the west. The farm is east, and directly below Mr. Palmer's. The wheat of this farm occasionally shrinks and blights, while that of Mr. Palmer's never does, but is always plump.

Water	9·88
Silicates	79·00
Peroxide of iron and alumina	7·84
Carbonate of lime	0·50
Magnesia	0·26
Soluble silica	0·06
	97·54

The phosphates are not appreciable in 100 grains, but in 1000 grains they become appreciable. The soluble silex of this quantity = 2·50 grains.

Another specimen of surface soil gave

Water	9·88
Organic matter	79·92
Peroxide of iron and alumina	8·50
Carbonate of lime	0·42
Magnesia	0·20
	98·92

Color of the soil dark brown.

Soil from a hill west of Christian-hollow.

Situated on the south side of Fall creek, where it cuts through Bear mountain, southeast corner of the town of Lafayette. It gives a good wheat crop.

ANALYSIS.

Water of absorption	2·00
The well dried soil gave	
Organic matter	10·15
Silicates	71·35
Peroxide of iron and alumina	7·45
Carbonate of lime	12·05
Magnesia	1·60
Soluble silica	0·09
Phosphates	a trace.
	102·05

Surface soil from the farm of T. & W. Spence, Christian-hollow.

ANALYSIS.

Water	5·60
Organic matter	8·72
Silicates	77·84
Peroxide of iron and alumina	5·00
Carbonate of lime	1·76
Magnesia	1·04
Soluble silica	trace.
	99·96

Phosphates not appreciable in 100 grains.

Good wheat soil, and has been under the plow for the last thirty years, and manured four times. It is a mixture of reddish clay and debris from the neighboring rocks.

Analysis of a red clay from Christian-hollow.

Compact, fine grained, and nearly without grittiness between the teeth.

Water	13·64
Organic matter	2·72
Peroxide of iron and alumina	27·40
Carbonate of lime	8·29
Potash	2·60
Magnesia	1·36
Soluble silica	0·24
Silica	44·84
	100·00

This clay furnishes, what might have been expected, a respectable quantity of potash ; and the composition of the material shows that it may be used to ameliorate the exhausted soils, in those places where the expense of the work will not exceed that of other modes. It is evidently adapted to soils which are light and deficient in lime. The potash was obtained without fusion with an alkali.

The result which has been obtained from the preceding analyses, is one which was quite unexpected. It appears that those soils which are so well adapted to the cultivation of wheat, are comparatively destitute of the phosphates, only a few analyses having given an appreciable quantity in one hundred grains. Four hundred grains of the wheat soil of Monroe county were tried for the phosphates, but without obtaining a trace. In 1000 grains they became appreciable, but did not amount to more than 0·20 of a grain.

In this result, we find a remarkable difference in the maize and wheat soils ; the former requiring the phosphates, while the latter does not require them in a quantity so decisive. But other qualities are essential to the growth of wheat, which are not requisite for maize. The former, for instance, must be supplied with organic matter in combination with the alkalies and alkaline earth. When a wheat soil is treated with water, it dissolves twice the quantity of the organic salts that we have obtained from the maize soils of the Taconic district. A fact which supports this view of the subject, is found in the crops of maize grown upon some of the western wheat soils : they are smaller, and inferior to those raised upon the taconic hills.

In Christian-hollow, the farm of Mr. Palmer produces wheat which is always plump in the grain, and in quantity equalling the premium crops ; yet the maize crop, upon the same soil, yields only about forty bushels per acre, and sixty bushels would be considered a remarkable crop.

We have already given our views of the origin of the wheat soils of Central New-York, namely, that they originate from the shales below the Manlius waterlimes, those soft and decomposable deposits which form the salt rocks. In the lowest member of this deposit, we obtained a trace of phosphate of alumina ; but the method, though one recommended and followed by chemists, is certainly exceptionable. The shales above the red marl appear to be destitute of phosphates, but the whole series contain a notable quantity of organic matter; and, hence, by the constant decomposition, they furnish a fresh quantity of food for plants.

We are now prepared to give additional results in regard to the class of soils holding a position above the wheat soil. This class belongs to the same formation as that which composes a large portion of the Southern district. In one respect, the soils of this class resemble those of Rensselaer and Washington counties, or in general those of the Second district. The phosphates are invariably present, and the lands are superior for indian corn.

Surface soil from the farm of Mr. N. Salisbury, of Scott, Cortland county.

The growth of timber is thrifty, consisting of beech, maple, ash, bass, oak, walnut and chestnut: hemlock grows upon the colder sides of the hills. The rock beneath belongs to the Ithaca group. The farm is situated on a slope of 3°, and the soil has been under cultivation twenty-seven years; five years in meadow, and the remainder of the time under the plough. In 1845, maize, which was manured in the hill, yielded seventy bushels per acre, of the large 12-rowed ears. The seed was soaked in a solution of sulphate of iron; and before the plant appeared above ground, a mixture of four bushels of ashes, three of lime, and two and a half of salt, were sowed over the field. This soil formerly bore good wheat, but latterly this grain is liable to shrink, although the practice of sowing with lime increases the value of the crop.

ANALYSIS.

100 grains, dried thoroughly, lost 3·80 grs.

	First process.	Second process.
Organic matter	16·28	0·00
Silica and silicates	75·92	73·52
Peroxide of iron and alumina	5·96	0·00
The same combined	0·00	2·35
Carbonate of lime	0·22	0·00
The same combined	0·00	0·27
Magnesia	0·18	0·00
Soluble silica	0·50	0·00
Phosphate of the peroxide of iron and alumina	0·50	0·00
	99·56	75·94

It should have been observed, that in some of the soils which have been analyzed, the water appears in excess. They were collected about one month prior to their examination. They were put up in papers, and packed and sent in boxes, and hence could not be considered as wet, inasmuch as the papers were entire and sound. Their feel was dry; and as the water was not imbibed by the wrappers so much as to break them, they could not contain a quantity much exceeding the ordinary water of absorption.

Soil from Homer flats, Cortland county.

Surface soil, color dark brown, and very deep ; receives the wash of a neighboring hill. Bore maize in 1846 : 420 bushels were harvested from four acres ; variety 8-rowed, yellow, and middle size. The land was brought under cultivation forty years ago, and has been under the plough most of the time since. The field has borne, during this time, ten crops of maize ; average yield, sixty bushels per acre. It formerly bore good winter wheat, and now bears very good spring wheat ; but the winter wheat is uncertain, and is liable to shrink and fail. The formation is above the Hamilton shales, and the rock is equivalent to the Ithaca group.

ANALYSIS.

Being dried thoroughly, it lost 8·40 grs. The dried soil gave, by the

	First process.	Second process.
Organic matter	8·16	0·00
Silica and silicates	73·20	67·02
Peroxide of iron and alumina	14·02	0·00
The same combined	0·00	5·18
Potash	3·16	0·00
Lime	0·25	0·00
Soluble silica	1·20	0·00
Magnesia	trace.	0·00
	100·99	72·20

Phosphates appreciable.

Soil from the farm of Mr. N. Salisbury.

This is a good indian corn soil, and yields also good crops of potatoes, oats, barley and grass. It formerly bore good winter wheat, and now produces good spring wheat by liming. Maize this year (1846), seventy-five bushels per acre. The seed, before planting, was soaked in sulphate of iron, which seemed to give it an early start. The land received also a compost of three bushels of lime, four bushels of ashes, and one bushel and a half of salt, per acre. The hills were manured from the hog sty. The land has been under cultivation twenty-nine years ; during this time, it has been down to grass eight years, and the remaining twenty-one years under the plough. In 1844, twelve bushels of lime per acre were sowed upon the field, and maize was then planted : the field contained five acres. A part yielded eighty bushels per acre, and the rest seventy-five. Spring wheat, in 1845, yielded thirty bushels per acre, using no manure. Farm situated on a slope of 4° : rests on the Ithaca group.

ANALYSIS.

100 grains, in drying, lost 6·16 grs. 100 grs. of the dried soil gave

Organic matter	15·92
Silica	72·76
Peroxide of iron and alumina	7·76
Potash	1·26
Carbonate of lime	0·86
Magnesia	0·28
Soluble silica	0·35
Phosphate of alumina, and phosphate of the peroxide of iron	0·43
	99·62

The formations which succeed the Marcellus slate are much coarser; and we often, or perhaps generally, are able to detect mica in the strata, and distinct grains of quartz. The soil also contains occasionally primary rocks; and it is possible to recognize, by the aid of the microscope, comminuted hornblende; but this is by no means a common ingredient, in a form which can be distinguished, as in those soils which are derived more immediately from the primary ranges.

We believe the phosphates are derived from the formation upon which the soil reposes, inasmuch as they appear to be composed of materials similar to those of the formation itself. That the phosphates, as has been maintained, are generally distributed, there can be no doubt; but some formations are richer than others. We believe that those wheat soils which give but a moderate crop of maize, require only the addition of those manures that furnish the phosphates, particularly ground bones, and the ashes of vegetables. The same fact, we believe, holds good also in relation to the cultivation of wheat in the slate district upon the western slope of the Green mountains. This opinion is supported by the frequent occurrence of good crops in this district, when the soil is properly prepared. Even a part of the range furnishes a true wheat soil, and quite similar to that of Western New-York. We refer to the Albany and Champlain tertiary clay, which is a homogeneous formation, extending through the vallies of Lake Champlain and Hudson river, and even onward northerly through the St. Lawrence basin.

A few soils only upon this formation have been critically examined. A single example of a soil upon this clay, and largely mixed with it, we annex, for the purpose of adding something to the few examinations we have as yet made of this particular formation. The soil was selected from the farm of the Rev. David Lamb, of Bridport, Addison county, Vermont. The slope was gently to the west. Soil rather light-colored, and a portion of taconic slate is mixed with it, undergoing disintegration.

The yield of this piece of ground was at the rate of 53½ bushels of winter wheat to the acre. The soil gave, on analysis, soluble silica, and the phosphates were distinctly appreciable in 100 grains.

We subjoin to the foregoing analyses a statement of the several tests, made for the purpose of ascertaining the presence of soluble silica and the phosphates.

1. Marcellus slate soil, Manlius. 100 grs. gave
   Soluble silica .... 0·15
   Phosphates .... a trace.

2. Soil of Mr. Geddes's farm, Fairmount. 100 grs. gave
   Soluble silica .... 0·19
   Phosphates appreciable. This is one instance in which the phosphates have been detected in this peculiar soil.

3. Mountmorris, or soil of the Genesee flats. 100 grs. gave
   Soluble silica .... 4·167
   Phosphates not appreciable in 100 grs. It is possible, however, that 100 grains, freéd of water and organic matter, would give indication of the presence of phosphates.

4. Cayuga clay, cropping out on Cayuga lake, and used for brick.
   Soluble silica, a trace.
   Phosphates not appreciable.

5. Harmon's wheat soil, Wheatland.
   Soluble silica evident in 100 grs.
   The phosphates not appreciable in 400 grs.

6. Soil from the farm of Mr. E. Ball, Hoosic falls.
   Soluble silica, a trace.
   Phosphates, a trace.

7. Soil in which the *Kalmia latifolia* grows well: situated upon the ravines underlaid by the Marcellus slate.
   Soluble silica .... 0·05
   Phosphates inappreciable.

8. Soil from the farm of Mr. Levi Hopkins.
   Soluble silica .... 0·05
   Phosphates .... a trace.

9. Albany clay.
   Soluble silica, a trace.
   Phosphates quite evident.

10. Niagara clay.
    Soluble silica, a trace.
    Phosphates not appreciable.

11. Peat, from Hoosic falls.
    Soluble silica .... 0·32.
    Phosphates not appreciable.

X. SOURCES OF THE PHOSPHATES WHICH ARE FOUND IN THE CORN AND GRAZING SOILS OF NEW-YORK.

It has been supposed that the phosphates were derived from the comminuted primary rocks contained in soils. Professor Fownes, author of a well known prize essay, has given, in an appendix to his work, several analyses which he had made for the purpose of settling the point whether the phosphates were contained in the ordinary granites. His results confirmed his suspicions, namely, that the phosphates were generally appreciable in the granites, when a thousand grains were operated upon. In the New-England soils, the disintegrated gneiss, mica slate, and granite which composes in the main those soils, contain the phosphates of the alkalies and alkaline earths. In two of the districts which we have closely examined, the phosphates are quite abundantly locked up in the rocks, and may be obtained when the analysis is conducted with ordinary care. Suspecting that the taconic slates might contain these important elements, several analyses were undertaken for the purpose of ascertaining the truth of my conjectures. It was not, however, the principal object to test the question merely for the local fact, but for the purpose of ascertaining a more general result, one which should have an important bearing upon a widely extended formation. I therefore selected a specimen of the taconic slate from Waterville, Maine, and several from Washington county, New-York. Prof. Jackson, in his survey of Maine, had found phosphates of magnesia in those soils; and as the slates of Waterville are identical with the New-York slates which belong to the same system, it appeared highly probable that this formation would be found to contain the phosphates which had been detected so frequently in the soils which rest upon those slates. I give the following results, as the analyses show other elements of importance besides the phosphates. No. 1 is the Hoosic roofing slate, which contains the beautiful fucoid that I have already referred to, when treating of the Taconic system; No. 2 is the Waterville slate, Me.; and No. 3 is the crystallized taconic slate, near and just west of the village of Salem, Washington county.

ANALYSIS.

	No. 1.	No. 2.	No. 3.
Water	3·79	3·42	2·62
Silica	70·55	71·62	84·65
Alumina and peroxide of iron	20·35	23·25	11·53
Carbonate of lime	0·99	0·10	0·60
Potash	3·52	1·52	0·00
Carbonate of magnesia	0·40	0·05	0·60
Soluble silica	trace.	trace.	trace.
Phosphates	trace.	0·90	trace.

The potash obtained was merely a trace; and the phosphates did not appear, until the solution had been standing twenty-four hours in No. 3.

The specimen of taconic slates belonging to New-York, not proving so rich in phosphates as that from Maine, I made an examination of another specimen, which was softer, as No. 3 had proved more siliceous than was anticipated. Hence I selected a soft variety, which occurs in a compact slate at Salem, and which is extensively used for the foundation of buildings. As my object principally was to ascertain the constancy of the phosphates in these slates, I proceeded no farther than was necessary to test, in a satisfactory manner, this question. A solution, therefore, of 100 grains was made, after thorough boiling in chlorohydric acid; the solution was freed from silica, and the alumina, iron, etc. with the phosphates precipitated. The last precipitate was again dissolved, and exactly neutralized by caustic ammonia; when acetate of potash threw down, in a short time, a large quantity of the phosphates. From this examination, it appears that the phosphates are commonly present in these slates, and greater in amount in the softer than in the harder and more siliceous ones.

It will be observed that the roofing slate of Hoosic contains quite a large percentage of potash. This potash may be in a larger quantity in the fucoidal slate, than in those which are destitute of the marine productions.

From the foregoing observations, we are furnished with a clue to the source of the important elements, potash, and the phosphate of alumina, iron and lime, which are so frequently contained in the soils of the Eastern or Taconic district.

We may now proceed to state the results which we have obtained by a special examination of the softer shales and slates situated geologically above the Tully limestone. I selected, for this examination, a specimen of slate from a quarry south of Cortlandville. It was greenish, and contained the fossils which characterize the Ithaca group, or the lower part of the Chemung group.

ANALYSIS.

Water	3·03
Silicates	83·50
Peroxide of iron and alumina	12·56
Carbonate of lime	0·61
Magnesia	0·30
	100·00

Phosphates appreciable in 100 grs. Potash was not obtained. The presence of phosphates was clear and distinct.

From this examination, we find an explanation of the fact why indian corn is a better crop upon those lands situated above the Onondaga-salt group, than it is below or immediately upon this series, inasmuch as it has been shown that the Onondaga-salt group is comparatively destitute of the phosphates.

Where fossil remains are abundant, we may always expect to find phosphates. In the above analysis, we selected a piece which was destitute of organic bodies; and it seems therefore highly probable that the rock, independent of fossils, contains them very generally, especially the softer kinds.

The Tully limestone was also analyzed, and found to contain a large amount of phosphates.

In conclusion, we are quite satisfied with the results which have been obtained by these examinations; and as they lead to practical results, and explain some facts which were at first obscure, we think the labor and time bestowed upon them will not be lost or useless.

In the vicinity of Christian-hollow, and indeed through a wide region of country, there are many marl ponds, some of which are situated in a manner similar to the small green lakes of which something has been said already. In connexion with the foregoing analyses, I deem it proper to give the composition of the marl which has been obtained from one of these ponds in the town of Preble. The annexed cut, fig. 38, will convey an idea of the mode in which they are distributed over the country.

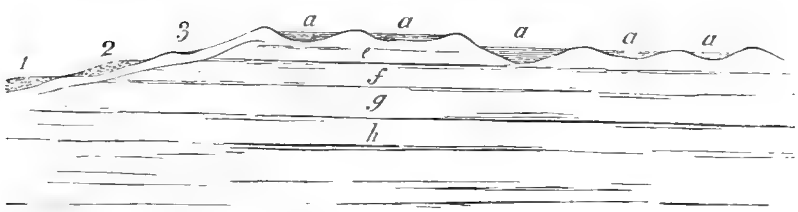
ANALYSIS.

Organic matter	3·01
Water (dried at 212°)	5·68

The composition of 100 grains, deprived of water and organic matter, is

Silex	11·68
Alumina and peroxide of iron	0·43
Carbonate of lime	86·84
Magnesia	0·64
Potash and soda	0·48
	100·07

Fig. 38.



A north and south section, running in the range of five or six marl ponds or small lakes, and extending between five and seven miles, or from the south end of Christian-hollow, to a point near Cortlandville. The lakes are above the Green lakes of Manlius, being mostly in a position superior to the Tully limestone. The slopes 1, 2, 3, consist of a succession of terraces, which form the offset into Christian-hollow.

XI. PREMIUM CROPS IN THE STATE OF NEW-YORK.

The general character and productiveness of the soils of New-York may be farther shown, by a statement of the amount of the premium crops which have been reported in the journals of the day. It is proper first to observe, however, that it is the practice, in all parts of the State, to take one or two crops of wheat from the newly cleared lands, and these crops are usually much above the average of the State.

Premium crops of wheat.

Commencing with those crops for which premiums have been awarded, we find, that in 1841, Mr. George Schaffer, of Wheatland, Monroe county, received the State Society's premium for that year, for having harvested 300 bushels of wheat from 7½ acres: this gives an average of forty bushels per acre.

The Society's first premium, in 1845, was taken by Edward Rivington, of Vernon, Oneida county, for having raised 110 bushels and 20 pounds of wheat upon two acres. The yield per acre, according to this statement, was $55\frac{10}{16}$ bushels.

The Society's second premium was awarded, the same year, to Stephen B. Dudley, of Ontario county, for having harvested 112½ bushels of wheat from two acres, giving an average of over 50 bushels per acre.

The third premium was taken by Abraham Fairchilds, of Arcadia, Wayne county. He raised upon one acre, which was sown to Soule's variety, 51 bushels; and upon an acre sown to white flint, $39\frac{16}{60}$ bushels.

Mr. Wright, of Vernon, Oneida county, made application for a premium, for having raised 79 bushels of wheat upon two acres. Daniel Gates, of Madison, made application also for a premium, for having raised 44 bushels per acre.

The Agricultural Society of Cayuga county report that Sarah Warner raised 420 bushels of wheat upon 11 acres; thus averaging $38\frac{11}{60}$ bushels per acre.

Thomas Ogden, of the same county, it is also reported, raised 38½ bushels per acre.

Mr. Gaylord, of Onondaga county, whose farm is based upon the Onondaga limestone, raised, in 1841, 400 bushels of wheat upon 18 acres, making an average of 22 bushels per acre.

The foregoing statement respecting the amount of premium crops, embraces only those which were raised in the Wheat district proper. That these crops have been equalled, and perhaps occasionally exceeded in amount, is probably true. The essential difference, however, which it is proper to note, is that in the Wheat district large crops may be raised for years in succession upon the same land; while in the other districts, the soil is exhausted by two crops, or three at most.

The County Societies' premium crops of the Hudson and Mohawk district, for 1845, were as follows:

To Rufus Stephens, of Lewis county, a premium was awarded for having raised 43¾ bushels of white canada flint wheat upon one acre.

The second premium for wheat, in the same county, was awarded to Israel Knight, of Lowville, for having raised 34 bushels and 13 quarts upon one acre.

In the Taconic district, the reported crops are as follows:

James T. Green, of Jackson, Washington county, raised 44 bushels and 3 pecks of wheat upon one acre. The land had been cleared five years, but no crop had ever been taken from it. The seed sown was $1\frac{1}{2}$ bushel per acre.

James Stephenson, of Argyle, Washington county. The field contained 4 acres, and had lain to pasture 3 years: the 4 acres yielded $44\frac{23}{32}$ bushels.

In 1841, Washington County Society awarded their first premium to John A. M'Neal, for having raised 29 bushels of wheat per acre; and the second premium to Alanson Cherry, for having raised $21\frac{1}{3}$ bushels per acre.

In the Southern district, the following crops are reported:

Artemas Bigelow, of Benton, Yates county, raised 87 bushels of wheat upon two acres, equalling $43\frac{1}{2}$ bushels per acre. Over the two acres from which this crop was taken, 30 bushels of the ashes of burnt wheat straw were spread. In addition to this, the field received 30 wagon loads of compost, made of barnyard manure, ashes, and lime well slacked, upon which plaster was sprinkled in successive layers: this was spread and ploughed in.

In Cortland county, Oliver Shedd raised, from 219 square rods, $42\frac{1}{2}$ bushels of wheat.

Reports of premium crops might be still farther multiplied, but we deem it unnecessary, inasmuch as they all amount to about the same average; some exceeding a few bushels, and others falling short in about the same ratio, the favorableness or unfavorableness of the season increasing or diminishing the crop in the same district.

Premium crops of maize.

The New-York State Society awarded, in 1841, a premium to William Ingalls, of Oswego county, for raising 142 bushels of maize on one acre of land; and another or second premium to I. F. Osborn, for raising 144 bushels on an acre: the measurement, however, was not wholly satisfactory.

The Tompkins County Society report, that 113 bushels of the Dutton corn was raised per acre; 105·51 bushels of Brown corn per acre, and $99 \cdot 36\frac{3}{4}$ of the China-tree corn per acre, each bushel weighing 56 pounds. From another statement, we learn that $92\frac{1}{2}$ bushels of maize per acre were raised by Elias I. Ayers.

The Orleans Agricultural Society report a premium for 112 bushels and 30 quarts per acre.

The Niagara County Society gave a premium for 106 bushels and 44 lbs. of maize per acre; also 71 bushels per acre were raised by Mr. Newhall.

The Washington County Society gave a premium to Job Eldreds for having raised 122 baskets upon an acre, each basket holding $1\frac{15}{32}$ bushels of maize.

Mr. Woodward, of Onondaga, raised 1460 bushels of maize on 20 acres, making an average of 73 bushels per acre. Mr. Hiram Church, of the same county, raised 200 on 4 acres, giving an average of 50 bushels.

The State premium for 1845, for the best crop of indian corn, was awarded to George Vail, esquire, of Rensselaer county. The field upon which it grew lies two miles east of Troy, and the soil is derived from the Taconic slate. The crop was $182\frac{1}{2}$ bushels, the largest, or one of the largest, ever raised in the State. This great yield, however, was the result of full and free manuring.

Mr. Geddes, of Onondaga county, raised, in 1844, $70\frac{1}{2}$ bushels of maize to the acre: the land had received 50 loads of half-rotted barnyard manure. In 1845, the same land yielded 67 bushels per acre, without an addition of manure. In another experiment, $60\frac{1}{2}$ bushels per acre were obtained in 1844, without manure; in 1845, it yielded 65 bushels. In two other experiments, when the land was manured in the furrow by 150 loads of unfermented manure to the acre, the products were 70 bushels in 1844, and $71\frac{1}{2}$ in 1845. The yield was carried up to 80 bushels per acre, by giving a top dressing of 25 loads of manure to the acre, in addition to that which it received in the furrow.

The premium crop of maize, for Lewis county, in 1845, was 93 bushels and a fraction per acre. This county belongs to the Champlain division mainly.

The premium crop for Oneida county, was 89 bushels and a fraction. It was grown in Kirkland.

Charles W. Eells, of Oneida county, received the County Society premium for raising 89 bushels and 5 lbs. of maize per acre; and G. L. Sherwood, of Oswego county, raised 133 bushels per acre (the land, however, was not measured).

Elias I. Ayers received the premium of the Tompkins County Society, for having raised 98 bushels and 24 quarts of maize per acre.

Calvin Skinner, of Cambridge, Washington county, raised $131\frac{26}{32}$ bushels of maize per acre.

John M'Naughton, of Salem, Washington county, raised 128 bushels and 18 quarts of maize per acre.

It will be observed, from the foregoing statement, that maize is a crop which succeeds well in the Taconic district; and that its yield is, upon the whole, superior to that in the Wheat district.

Premiums awarded by the State Society for crops of oats, in 1841.

The first premium was given to D. W. Week, of Watertown, Jefferson county, for raising $113\frac{1}{2}$ bushels of oats per acre.

The second premium was awarded to John S. Jones, of East-Bloomfield, Ontario county, for raising $102\frac{1}{2}$ bushels of oats per acre.

A premium was awarded to Amos A. Eggleston, of Washington county, for the peculiar excellence of his oats; a bushel weighing 42 lbs., and the crop also being large. This crop amounted to $48\frac{2}{3}$ bushels, as reported by the County Society.

Mr. Gaylord, of Onondaga county, raised 200 bushels of oats on 5 acres.

Mr. Woodward, of the same county, raised 360 bushels of oats upon 6 acres, averaging 60 bushels per acre.

Premiums awarded by the State and County Societies for crops of oats, in 1845.

The State Society's premium was awarded to Elias I. Ayers, of Tompkins county, for having raised 183 bushels and 3 pecks of oats on 2 acres, equal to 91 bushels and 28 quarts per acre.

The Cayuga County Society gave a premium on a crop of oats, averaging $64\frac{1}{2}$ bushels per acre; and another to Lewis county, equal to $90\frac{3}{33}$ bushels per acre.

Mr. Nicholas I. Bort, of Oswego county, raised $106\frac{1}{2}$ bushels of oats on one acre, measured when first cut or gathered The bushel weighed 33 pounds and 4 ounces.

Mr. Helim Sutton, of Seneca county, raised $83\frac{3}{32}$ bushels of oats per acre.

Mr. A. Thompson, of Washington county, raised $86\frac{1}{2}$ bushels of oats upon 150 roods of land.

The reports of the County Societies, respecting the premium crops, are far from being full. It would be advantageous to make the return perfect from all the counties. We should then be able to determine the relative power of the soils in the State, and practically their value or adaptedness to the different kinds of husbandry. Observation ought also to be directed to the capacity, as well as adaptedness of position to the different crops in the same district; inasmuch as there is but little probability that an entire district is fitted exclusively to one or two kinds of grain. Oats seem to possess an aptitude to accommodate themselves to a wide range of latitude. We are not yet in possession of a sufficient number of facts to be able to judge of the quantity which our lands ought, under proper cultivation, to yield.

TABLE OF STATE AND COUNTY PREMIUM CROPS FOR 1846;

EMBRACING ALSO OTHER LARGE CROPS NOT ENTERED FOR PREMIUMS, WITH THE EXPENSE OF CULTIVATION, AND VALUE OF LANDS PER ACRE.

COUNTIES.	WHEAT.	MAIZE.	OATS.	Cost of cultivation.	Value of land.
	Per acre	Per acre.	Per acre.		Per acre
Oneida.......	55 & 39¾ bushels.	88 & 89 bushels.	..	\$52·61 for 2 acres.	\$40·50
Ontario	56¼				
Wayne........	39⅓	..	..	\$18·35 for 1 acre.	\$30·00
Madison	44				
Cayuga	38	..	64 bushels.	\$207 for 11 acres.	\$100·50
Yates	41¾				
Onondaga	..	60, 65, 71, 80			
Rensselaer ...	..	182½	..	\$79·79 for 2 acres.	\$100·00
Washington ..	11, 44, 29 & 21½	131, 128	..	..	\$70·00
Lewis	..	93	90, 106½	..	\$50·50
Oswego	..	142, 93	106		
Tompkins	..	113, 105, 99, 133, 98	91		
Seneca	..	..	86		
Niagara	..	106			
Orleans	..	112			

TABLE SHOWING THE TIMES OF SOWING AND REAPING IN MONROE COUNTY.

YEARS.	MAIZE.			WHEAT.	BARLEY.		OATS.	
	Planted	Harvested	Growth.	Harvested	Sowed	Harvested	Sowed	Harvested
1840	May 19	Sept. 17	121 days.	July 18	April 17	July 28	April 10	
1841	" 23	" 6	107 "	" 20	" 23	" 29	" 26	Aug. 4
1842	" 6	" 20	137 "	" 25	" 14	Aug. 2	" 1	" 16
1843	" 18	" 29	134 "	" 26	" 25	" 2	" 20	" 9
1844	" 10	" 14	127 "	" 15	" 1	July 12	" 18	July 25
1845	" 6	Aug. 20	106 "	" 15	March 28	" 14		

XII. THE POWER WHICH SOILS POSSESS OF ABSORBING AND RETAINING WATER.

Our account of the New-York soils would be incomplete, if we passed over in silence these important qualities, which all soils possess in a greater or less degree. The determination of this power can be satisfactorily ascertained only by an extensive series of experiments carefully conducted, during the summer months, or during that period of the year when vegetation is affected by atmospheric changes. At any rate, experiments performed during the winter, the early spring, or late in autumn, would not be so satisfactory as during some portion of the period when vegetation is active and energetic. Experiments were commenced and pursued for a week or more, but they were suspended partly for want of time at command, and partly from the fact, that all the experiments and observations appeared to lead to and establish the result, that the powers in question were in the direct ratio to the quantity of organic matter in the soil, though modified by its state of subdivision; for it appeared, that when the subdivision was excessive, the soil absorbed and retained water in its maximum degree; and when coarse, or but imperfectly divided, its power of absorption and retention were proportionally diminished: still it was evident, that even when the organic matter was coarse, those powers were much greater than when the soil was deprived of matter from the vegetable kingdom. The facts being established, that the power of absorption and retention are in the ratio of the quantity of organic matter, modified by its state or condition, it shows that soils may differ in those powers, even when by analysis the amount of organic matter is nearly the same. It becomes important, then, in a practical point of view, to secure a proper degree of fineness in the vegetable and animal matters which are added to soils, inasmuch as they will be much more effective as fertilizers in a given period than if they were coarse; for it is during the dry season, that vegetables require a soil which is both absorptive and retentive. That soil which is capable of seizing atmospheric water, and holding it when the atmosphere is heated, is one of the best constituted soils.

The preceding observations, we believe, may be easily confirmed by other observers, if they will but turn their attention to the varieties of loam, or any of the mixtures of sand and organic matter, or organic matter and clay.

Another fact, which is equally important with the foregoing, and which was determined while engaged in these experiments, is the order in which the different materials composing the soils stand to each other, or the relations which they severally hold to each other in their separate capacity. For example, it was observed that marls, or the finely divided calcareous compounds, are quite powerful absorbers and retainers of water, being even superior to clay and the argillaceous compounds, or to alumina in a state of great purity. This result was quite unexpected; as the common and prevailing opinion is, and has been, that clays are the most active and energetic in their powers of absorbing and retaining moisture.

In accordance, then, with these observations, we found that the materials which are most influential in soils, may be arranged in the following order, when their relations to water or moisture are considered: 1. Peat, or pure organic matter; 2. Marl, or, to be explicit and definite, freshwater or shell marl; 3. Clay, and argillaceous compounds in which this element is in excess; 4. Loam, or the common soils as they usually occur; 5. Sandy loam; 6. Sand. Each of these kinds of earth is influenced, in its power of absorbing and retaining water, by the amount of peaty matter which it contains, subject to modification by its fineness.

That it is the vegetable or organic matter contained and intimately combined in soils which give them in the main their powers, is supported by the fact, that when it is destroyed or removed by ignition, very little difference exists among them as it regards the powers in question. This statement is confirmed when experiments are made upon marl and clay first in their natural state, and afterwards when ignited. In the condition to which they are brought by this process, they differ but a trifle from each other, as it regards the amount of moisture they will absorb in equal times and under similar conditions. It seems, that after burning, the different kinds of soils are brought down to the same standard. Thus, in fifteen samples of soils selected from different districts, some of which were clay and sand, together with peat and marl, on being ignited, they absorbed nearly equal quantities of moisture in equal times: they at most differed only between one and two grains in the amount of water which they absorbed. Two hundred grains of soil were selected for these experiments: they were first moistened with water, till perfectly imbued with it, and, in four hours, they were weighed. This operation was repeated at equal intervals, for many times in succession, and always with the same results; the peat, or nearly pure vegetable matter, scarcely losing any water in the course of a few hours, while sand would lose almost all its water, and become nearly dry. After they were ignited, however, they dried sensibly at the same rate; or when left to absorb moisture after undergoing this process, the sand absorbed nearly as much water as the marl or clay, or the common soils which had been burnt.

From the foregoing statements, it is evident that soils ought not to be subjected to the process of paring and burning, without special reasons. If there is no objection to burning, on the score of the loss of organic matter, together with a loss in its power of absorbing moisture, then the process will be followed with advantageous results; for it is unquestionably true that the mineral or organic matter is more soluble in consequence of having been ignited. Sandy soils, and all the varieties of loams, are rarely improved by burning. When all the vegetable matter is burned off, they must necessarily be injured. So, on the other hand, the addition of finely divided vegetable matters, if it served no other purpose in soils than to aid and assist in the absorption and retention of moisture, this purpose itself would be quite an important one, and worthy of being secured. Water, in due proportion, must always be regarded as one of the essential elements of a good soil: it is, as it were, the moving power. In this light it would be regarded, if it was merely the medium for transmitting nutriment through the body of the vegetable; but it is important in other respects, and hence growing plants must have a supply, or else they will suffer or die, according to the degree in which they are deprived of this element.

XIII. A SERIES OF TABLES, SHOWING THE COMPOSITION OF THE LIMESTONES, SHALES, SLATES AND MARLS OF NEW-YORK;

TOGETHER WITH REMARKS WHICH ARE DESIGNED TO SHOW THEIR PROBABLE INFLUENCE UPON THE COMPOSITION OF THE SOILS IN CONNEXION WITH THEM.

Limestones of new-york.

The geological formations embraced in the limits of the State, contain deposits of this rock. The superior part of the Silurian system, and the Old Red or Devonian of recent authors, are quite deficient in limestones, as has been already stated in the foregoing pages. The Primary system, however, is rich in limestone; but its qualities are usually defective, in consequence of its containing insoluble matter, as silica or quartz, mica, pyroxene, hornblende, etc. In the specimen of which I have given an analysis, which was taken from the beds in gneiss at the Natural bridge, Jefferson county, scarcely a trace of magnesia was found. This was an unexpected result, inasmuch as it is often associated with serpentine and other magnesian minerals. It may have happened that wherever magnesia and the other necessary elements were contained in the rock, they have been converted into serpentine, and the serpentine itself has been separated from the mass of limestone by segregation. The beds of primary limestone require no farther notice, as they have been fully described already.

The Taconic limestones are frequently magnesian, or dolomitic, as they have been called; and from my own examinations, I believe that all the beds which contain tremolite are magnesian. It appears, however, from the lamented Olmsted's analyses for the Vermont survey, that many of the friable limestones of this system are nearly pure carbonates of lime, and are destitute of magnesia.

The Sparry limestone was also found to be destitute of magnesia, at least so far as the specimen examined was concerned.

The limestones at the base of the Silurian system are quite magnesian, especially the Calciferous sandstone, and parts at least of the Trenton limestone. The Birdseye, and the Isle Lamotte marble, appear to be destitute again of magnesia, the latter containing only 3 or 4 per cent.

The Niagara limestone of the Ontario division can scarcely be called magnesian. The shales below contain some magnesia and soda; the latter, as it appears from the decomposing materials which are located in favorable spots, exists in large proportion.

The limestones become magnesian again in the lower part of the Helderberg division, especially the water limes. Magnesia is contained in the slaty thin-bedded, as well as in the thick-bedded limestones.

The Onondaga limestone is a pure limestone, or, in other words, is not magnesian.

The limestone of the Marcellus slate, as it occurs at Schoharie, Cherryvalley and Manlius, is probably magnesian: it has not been examined for this substance.

The Tully limestone is also destitute of magnesia, but is an impure limestone, and, in many respects, is well adapted to the formation of lime for agricultural purposes. This is the last and highest limestone in New-York.

The freshwater marls show some variation in composition, and they contain very little magnesia. Animal and vegetable matter, a trace of alumina and iron, form the principal impurities of the marls. Many are extremely valuable for lime, and may be as cheaply burned as the solid limestones. The lime is pure and snow white, and is excellent for whitewashing.

TABLE SHOWING THE COMPOSITION OF SEVERAL LIMESTONES IN NEW-YORK.

NAMES OF LIMESTONES.	Insoluble matter, silica, &c.	Alumina and peroxide of iron.	Carbonate of lime.	Magnesia.	Phosphate of lime.	Potash.	Soda.	Manganese.	Water and loss.	Soluble silica.
Calciferous sandstone...	6·20	4·50	58·86	27·20	..	..	..	..	1·62	..
Chazy limestone	27·62	18·03	49·00	3·60	..	..	..	..	1·74	..
Trenton limestone*.....	15·60	4·18	52·76	24·87	..	..	.	..	1·19	..
Niagara limestone......	0·68	4·24	93·40	..	..	.	..	..	4·68	..
Septaria†....	15·24	11·50	73·24	trace.	..	..	..	..	..	..
Onondaga limestone	3·74	0·18	89·00	4·00	0·03	..	..	..	3·02	..
Tully limestone........	27·61	10·34	54·10	0·34	0·88	1·80	trace.	..	4·93	trace.
Sparry limestone.......	7·40	1·60	91·00	..	..	..	.	..	..	..
Stockbridge limestone‡ .	0·29	..	99·51	trace.	..	..	..	..	0·20	..
Dolomite	..	7·70	60·20	33·04	..	..	..	.	..	..
Primary limestone‖.....	0·88	0·88	98·24	..	..	..	..	..	..	..
Black marble (Lamotte)‡	4·80	2·60	87·94	4·56	..	..	..	trace.	..	..
Swanton marble‡.......	2·39	1·09	94·66	0·23	..	..	..	..	..	..

* Plattsburgh; slaty. † From the Marcellus slate. ‡ Statuary marble by Olmsted, of Brandon, Vt. ‖ Natural bridge, Jefferson county.

Slates and shales of New-York.

As the slates and shales may be employed, under favorable circumstances, as fertilizers, and as they decompose by the action of the weather, rains and frosts, it seemed proper to ascertain their composition. Some of them have a wide distribution, and maintain a uniformity of lithological character, and probably of composition also.

The slates which are widely distributed, are the taconic and roofing slates. These pass through New-York from north to south, or in a direction nearly parallel with the Hudson river, which they cross obliquely above the Highlands. They continue through Orange county, and then pursuing nearly the same direction, traverse several of the States, in the range of their strikes.

The slates and shales of the Salt group are comparatively local, but they have an important influence on the soils of Central and Western New-York.

The Marcellus slate is often highly calcareous, and may then be employed as a fertilizer.

The Cortlandville shale probably represents the composition of a large mass of the rocks above the Tully limestone.

How far, and with what success, the rocks, particularly the slates which contain alkalies, may be used with ultimate benefit as fertilizers, may be judged of, when it is stated that the decomposed mica slates have been already thus employed. Dr. Jackson, in his New-Hampshire Report, gives the analysis of one which experience has proved valuable in this way by mixing its debris in a compost of peat, lime, etc.

ANALYSIS BY DR. JACKSON.

Water	3·6
Vegetable matter	1·8
Silica	79·2
Peroxide of iron and alumina	5·6
Potash	2·2
Soda	2·5
Lime	3·2
Magnesia	1·2
	99·3

The composition of this primary slate may be compared with the taconic slates. We do not, however, mean to convey the impression that slates and shales are definite chemical compounds; and yet there is little doubt but that analysis gives their general constitution, and that they will not be found to vary excessively from the composition which we have found them to possess.

COMPOSITION OF THE SLATES AND SHALES OF NEW-YORK AND OTHER PLACES.

NAMES.	Water and organic matter.	Silica.	Peroxide of iron and alumina.	Carbonate of lime.	Magnesia.	Phosphates	Potash.	Sulphate of lime.
Hoosic roofing slate	3·79	70·55	20·35	0·99	0·40	trace.	3·32	..
Slate from Salem	2·62	84·65	11·53	0·60	0·60	trace.	..	..
Waterville, Me.	3·42	71·62	23·25	0·10	0·05	0·90	1·52	..
Fairhaven	2·70	80·72	12·76	1·76	0·40	..	*	..
Welch roofing slate	2·64	78·76	16·64	0·36	0·52	..	*	..
Shale from Cortlandville	3·03	83·50	12·56	0·61	0·30	trace.	..	..
Cauda galli grit	6·00	81·54	7·00	1·76	trace.	..	..	..
Marcellus slate	4·25	48·12	10·00	36·60	1·00	.	..	..
Red slate or shale of the salt group,	6·48	68·86	14·98	9·89	0·40	0·14	..	..
Green shale of the salt group	5·56	34·56	13·36	43·06	2·17	..	..	1·06

* Loss may be set down as potash and the phosphates probably.

Clays of new-york.

Clays are highly important materials in the constitution of soils. They are also important fertilizers, especially when they contain lime, magnesia and potash; but they are more valuable in pottery and brick making. Some kinds of clay, as is well known, enter into the composition of the finest works of art — the porcelain ware. The expense of moving clay may be considered as the great bar to its use as a fertilizer, and yet its effects are most decided upon all lands which are denominated light.

The Albany or Tertiary clay extends through the vallies of the Champlain and the

Hudson, and exerts an important influence upon the agriculture of these vallies. It is an excellent base for agricultural work, and makes a desirable foundation for tillage.

A reddish brick clay appears on Cayuga lake, and is probably the same clay which exists in Christian-hollow.

The Adirondack clay is local, and is formed by the decomposition of the hypersthene rock.

COMPOSITION OF THE CLAYS OF NEW-YORK.

PLACES AND KINDS OF CLAY.	Silex.	Alumina and iron.	Carbonate of lime.	Magnesia.	Phosphates	Potash.	Water, loss and organic matter.
Tertiary or Albany clay..........	52·44	32·28	8·00	trace.*	trace.	trace.	5·28
Niagara clay....................	58·24	20·76	14·62	2·42	..	0·44	3·24
Cayuga clay	44·20	28·72	16·48	0·16	trace.	trace.	8·44
Adirondack clay	84·63	..	0·94	0·60	trace.	0·11	6·52
Brick clay near Caldwell.........	65·60	17·52	8·92	0·39	..	..	6·68
Reddish clay of Christian hollow,†	44·84	27·40	8·29	1·36	..	2·60	16·36

* A preceding analysis gave 1·62. † Common in the Wheat district.

COMPOSITION OF THE NEW-YORK MARLS.

PLACES.	Carbonate of lime.	Oxide of iron and alumina.	Organic matter.	Insoluble matter.	Water.	Magnesia.
Saratoga county	85·62	1·24	3·92	3·40	2·32	3·80
Fairmount: near Mr. Geddes',	21·24	.	..	..	..	..
Salem: Mr. Crary's farm.....	83·22	1·24	0·51	2·42	7·25	trace.
Christian-hollow	75·45	0·62	0·52	0·56	22·24	0·62
Cayuga bridge*.............	22·20	8·88	3·00	41·75	4·88	19·30

* Formed by decomposing plaster shales.

XIV. SUMMARY OF THE LEADING FACTS WHICH HAVE BEEN ASCERTAINED RESPECTING THE SOILS OF NEW-YORK.

1. The soils of New-York are often modified by the rock upon which they rest. Their composition, however, always differs from the rock, even when it is apparent that they were derived directly from the strata upon which they repose, or are in immediate contact. The differences are found to consist principally in the presence of those matters which are soluble by water when aided by carbonic acid, as carbonate of lime and magnesia. The soluble organic matters exist in a proportion greater in the soils than in the rocks; though all sedimentary rocks contain soluble organic matters, especially the decomposable shales and slates. The hard limestones exert but little effect or influence upon the composition of the soils: the most important office which they perform is mechanical, and the soil upon them is usually drier than upon the compact sandstones and shales.

2. The composition of the soils of the Eastern or Taconic district differs from that of Central and Western New-York, or those which belong to the Wheat district. The first contain a greater amount of the phosphates of lime, alumina, iron and magnesia; the last, a greater amount of nitrogenous matters. The derivation of the first may be traced to the rock upon which they rest: the same fact has been shown in respect to the last; and it is the peculiar constitution of the rock which makes them wheat soils, or gives them a fitness to sustain and perfect the wheat crop for a succession of years.

3. It has been shown that the soils of the Eastern district are closely allied to the Southern, or to those which rest upon the shales situated above the Onondaga limestone, particularly in the northern part of the Southern district. We find, in this range, soils which contain the phosphates, and which are fitted for the culture of maize. The amount of this crop is greater than upon the wheat soils below; and although wheat was formerly grown in the early settlement of the country, and may have been an important crop upon this higher shelf of land, still experience proves that it is not a durable crop; that it is more liable to shrink; and that now only spring wheat is attempted to be raised upon the lands, after they have been cultivated for a few years.

4. The soil of the Southern district is shown, by analysis, to be deficient in lime and magnesia. The lime which exists in it is mostly in combination with the organic acids, and is more abundant in the surface soil than in the subsoil. The vallies, those especially which are watered by the Susquehannah, Allegany and their tributaries, are better supplied with lime than the soils of the hill-sides.

5. The geological formations which are most favorable to the production of the greatest number of important crops, are those of the western and central part of the State; inasmuch as their peculiar composition, and the speedy disintegration of the rocks upon which

they rest, furnish new and fresh matter to supply the loss occasioned by the removal of inorganic matter in the crops themselves.

6. The supply of phosphates has been shown, by analysis, to be derived in the main from the rocks themselves; parts of the two systems supplying them in about equal proportions, namely, the Taconic slates, and the Hamilton and Chemung groups. The Tully limestone also furnishes the phosphates in about the same proportion; but, this rock being quite limited, its influence is not extensive.

7. The character of the soils which are now cultivated in New-York, has not been materially changed by diluvial action. This assertion will receive essential support, when it is recollected that the rocks upon the east side of the Hudson extend very far north; and that the force or power which transported the soil, moved it in the direction of the strike of the rocks themselves. In the middle and western counties, a very large proportion of the underlying rock crumbles down into a tillable soil in a short time after exposure. The transportation of the debris of those rocks, however, has extended the wheat-growing soil as far as the outcropping of the Hamilton and Chemung rocks in many places. The higher grounds, or the elevated parts of the district, covered by the Hamilton aad Chemung groups, have not received the debris of the Onondaga-salt group: they are furnished with soil which is derived principally from the groups themselves. It is always deficient in the alkalies and alkaline earths.

8. The iron in the wheat soils, and in the green shales, is in the state of a protoxide: indeed this statement holds good when applied to the Taconic slates. The soils, too, of the Wheat district, contain the protoxide principally; while in the maize-growing district, it is usually in the state of a peroxide. It is improbable that iron enters into the organs of vegetables, without first becoming a peroxide.

9. There are no soils in New-York, which are entitled to the appellation of calcareous soils. In the common language of the journalists of the day, they are either sandy or argillaceous loams. The peaty soils belong mostly to swamps or marshes, or which were so before they were reclaimed.

10. The means which are usually at hand for maintaining an uninterrupted fertility, are plaster, limestone, marl, tufa, peat, and decomposable shales. The distribution of the limestones is well delineated on the Geological Map. The peat and marl beds are generally distributed over the entire State, but they occupy only small basins in each of the geological formations. Lime is used too seldom; though its influences and effects are invariably decided, where there is a sufficiency of vegetable or organic matter. Hence one of the most important desiderata for the agriculturist, will be hereafter to secure a sufficient amount of organic matter, which may be used most efficaciously in the form of compost with marl and lime. Sulphate of lime is quite a constant ingredient in the soils of the eastern, central and western counties; and less common in the Southern, Northern, Highland and Atlantic districts.

11. The means for increasing the fertility of soil are much greater in all places than

may be supposed ; for example, all manufacturing establishments have various kinds of wastes, such as hair, wool, bones and animal matter, wood and horn shavings, coal dust and cinders, ashes, waste lime, coal ashes, apple pumice, in which, during decomposition, much ammonia and the phosphates exist ; carcases of dead animals, weeds of the yards of houses and barns, all of which ought to go into the compost heap ; turf by the road-side, and the wash of roads, which ought always to be turned upon meadows or pastures.

12. It is evident from the composition of the numerous beds of slate and shale which exist in all the sedimentary formations, that heaps of the fragments of these rocks might be turned to good account as fertilizers, provided a disintegration could be effected. In many instances, there is not the slightest difficulty in bringing them to a pulverulent mass. Where they resist decomposition, piles of the debris, if heated, would crumble more speedily to powder. If they were coarsely pulverized, the mechanical effects in many cases would be important, especially on the argillaceous soils ; and they would slowly yield up their potash and phosphates, magnesia and lime, to supply the annual waste to which the soil is subjected by cropping. Rocks which contain sulphuret of iron undergo a rapid disintegration, and afterwards a thorough decomposition. In these rocks are contained, in all cases, valuable fertilizers, which are available by the aid of quicklime. From them a large amount of gypsum may be obtained by means of the lime, in addition to the other soluble matters which the rock may contain.

13. In conclusion, I feel justified in saying that the available means within the reach of the farmers of New-York are much greater than has been supposed. The gypsum, marls, limestones, peat, and broken down shales, either gypseous or calcareous, and magnesian or pyritous, may all be turned to account, and may be employed at a reasonable expense, not only to sustain the soil in its present state of fertility, but to increase considerably its productiveness.

DESCRIPTION OF THE GEOLOGICAL MAP.

This map is a reprint, in the main, of the map which accompanies the first reports. Important additions, however, have been made to it. Parts of Vermont, Massachusetts and Connecticut are now included. In addition to these, the range of the Taconic system is colored, and made a distinct part of the map. It occupies a belt extending from the Canada line to New-Jersey and Tappan bay on the North river, below the Highlands. This system, it will be observed, is divided or split by the primary of the Highlands; the older part passing on the east side intersects the Hudson at Peekskill, and the superior portion passes on the west side and leads off into New-Jersey, passing through the county of Orange. The primary rocks of Massachusetts, Vermont, and Connecticut, which lie in a position nearly parallel to the Taconic system, are colored with lake, and the Taconic system a drab. By this addition, the relative positions of the New-York, Taconic and Primary systems of New-England are indicated. We may see the great primary nucleus of New-England as it disappears beneath the oldest sedimentary rock now known, composing the Taconic system; and the disappearance of the latter beneath the New-York system. The New-York system continues the superior system until we reach Green bay and the sources of the Menomone river, where the Taconic system once more appears, supporting the lower members of the New-York system, and reposing on and supported by the Primary, as in Massachusetts, Connecticut and Vermont.

The narrow belt of the Taconic system is a remarkable feature in the geology of this country; it being an immensely thick series, which seems to have been deposited in long and remarkably deep seas that resembled profound clefts in the crust of the earth.

The different members are not distinguished by colors: the difficulty of locating them with that degree of precision which is required in a map, was considered a sufficient reason for the omission. The oldest or inferior member, the gray sandstone or granular quartz, lies upon the primary in the range of Williamstown and Dalton, Massachusetts, and Arlington, Vermont. The Stockbridge limestone forms a belt immediately west; and then there is a belt of silvery talcose slate, or magnesian slate; beyond which the sparry limestone appears in a distinct range, which may be located with some degree of precision, when it is stated that the tunnel of the Great Western Railroad passes through it, which is not far from the line bounding New-York and Massachusetts. The members are regarded as the inferior rocks of the Taconic system. Still west of them there is a wide belt of taconic slates, which contains many subordinate beds of limestone and siliceous slate, and which frequently supports the outliers of the lower members of the New-York system. The Taconic system, as a whole, may be regarded lithologically as an immense slate system, with subordinate beds of sandstone and limestone, both of which are more largely developed upon its eastern border adjacent to the Primary system.

The New-York system is colored like the former map, which accompanies the volumes already distributed.

EXPLANATION OF THE AGRICULTURAL MAP.

The map extends into Massachusetts and Connecticut. The greater part of the area belongs to the Primary system, and is colored lake. The State is divided into six districts, and is numbered accordingly.

The first is the Highland district, and is colored lake: it occupies two distant parts of the State; the Southern is much the smallest, and is comparatively unimportant: it is much modified by the soils of the Eastern and Hudson river districts, which separate it from the Northern. This latter portion is underlaid by primary rocks, consisting of gneiss and hypersthene rock; the former is principally upon the outside, while the latter occupies the interior, and forms a remarkable nucleus, which is mountainous, and furnishes but little arable soil. It will be observed that many of the principal rivers rise in the northern highlands. The primary region is surrounded by sedimentary rocks which belong to the lower Silurian or New-York system.

The second district is the Eastern or Taconic, and forms a long narrow belt running nearly north and south. The rocks of this system divide at the highlands of the Hudson; the upper or superior rocks cross above, and the inferior below the Highlands: the former are slates, the latter slates and white and gray limestones. The district is colored drab. The hills run nearly north and south in the direction of the strike of the rocks; hence the transported materials, which often compose the soil, belong almost exclusively to the same rocks upon which they rest.

The Hudson and Mohawk district is the third, and occupies, in part, those vallies. It is colored blue. The rocks belong wholly to the lower part of the New-York system; the slates, however, seem to impart to it its characteristic features. The valley of the Mohawk is modified by the Northern Highland district. A belt of northern boulders crosses the district at Amsterdam. Primary soil is freely distributed through this part of the district. Lewis, Jefferson, and a part of the western part of St. Lawrence counties are embraced also in this district. The soils of this part of the district have been examined less than those in the Mohawk and Hudson vallies.

The Wheat district is numbered four. It extends from Herkimer to Oswego, and then westward along the south shore of Lake Ontario: its southern boundary runs through the middle of the smaller lakes, Cayuga and Seneca, to Lake Erie. A very large proportion of the soil of this district is derived directly from the red and green shales: the northern part, that which lies along the shores of Lake Ontario, is derived from the softer portion of the Medina sandstone. The soil is often drab colored, especially when derived from the red slate. The green shales furnish a light colored soil, but it is essentially the same as that derived from the red rocks.

The Southern district lies south of the former: it embraces the southern tier of counties. The vallies run north and south. The slates, shales and sandstones are deficient in calcareous matter: the soil also, especially in the higher places, is deficient in the alkaline earths generally. The vallies which have received the northern drift, which is largely mixed with the debris of the red and green shales, bear good crops of wheat. The pebbles which indicate this variety of soil are derived from the Niagara and Onondaga limestones.

The fifth is eminently a grazing district. The grass upon the slopes, which are watered with pure water, is sweet, and is relished by all kinds of stock. The butter which is produced from this district is not excelled by any in the State, especially that of Delaware county: I mean to say that it is equally good as the Orange and Herkimer county butter. The Orange county butter, however, is preferred in market, but probably in consequence of the superior mode in which it is packed.

Long Island, in consequence of its maritime position, is made a separate district. It is, however, probable that the soil of the northern side is derived from the Primary and Taconic districts: it is even here more sandy than either. The middle and southern sides are more sandy, and in fact consist of sea sand in many places.

EXPLANATION OF THE PLATES.

PLATE I.

It is designed to represent the valley of the Hudson at Albany, and the Helderberg range as it appears from the high grounds in the rear of Greenbush. The valley is colored yellow, and is a narrow alluvial formation reposing upon the tertiary or Albany clay. The immediate rock, and which appears at the Norman's kill, is the thick-bedded gray sandstone of the superior part of the Hudson river group; it extends nearly eight miles west, before it disappears beneath the calcareous shales of the waterlimes at the base of the Helderberg hills. The group which forms the Helderberg division appears in succession, and makes by itself a full and complete series, which ends with the Onondaga limestone at New-Scotland. The superior part of the Helderberg range, as represented in the panoramic view, is the Erie division. Upon the extreme left is the Catskill or Devonian division, which is colored red. The Pentamerus and Delthyris shale crop out at the main terrace on the right, and dip to the southwest. Still farther upon the right the Hudson river group, the thick-bedded sandstone, interlaminated with a black slate, forms the slope as it extends itself towards the Mohawk valley. The view is north and south. The lowest rocks belong to the Champlain division, the upper to the Catskill. The Ontario division is wanting in the series.

PLATE II.

The view is designed to exhibit some of the features of the Mohawk valley, particularly its vegetation. The elm, with its pendulous branches and small and numerous ones upon the trunk, has the common shape and condition of the red elm of this valley.

PLATE III.

The country about Rochester is richly exhibited from Mount Hope. The view looks toward the northwest. It is in Central New-York, and upon the argillaceous or wheat soils, that the splendid American elms flourish and attain a great height. They often appear without branches or limbs, until the trunk spreads as it were at once into a noble head. They form characteristic points in the landscape.

PLATE IV.

The Catskill creek, for four or five miles, forces its way through a region excessively disturbed: it is in fact a part of the great north and south fracture, in which insulated hills often appear, but still formed of rocks which seem have been forced upward and broken from the adjacent strata. This mass of Pentamerus rock forms a part of a segment of a great curve, the edges of which dip towards the centre. The inferior, the Hudson river group, is the lowest mass, and dips rapidly beneath the limestones.

PLATE V.

The panoramic view was taken from the northwest extremity of the Helderberg range, the observer looking east. The valley of the Hudson occupies the extreme of the middle grounds, the river itself appearing only at intervals. The foreground is occupied by the limestones of the Helderberg. The long narrow hills, with their narrow intervening vallies, appear in the back ground; but the distance is too great to exhibit their characteristics.

PLATE VI.

The view in Plate 6, represents a very common feature in the slate and thin-bedded sandstone hills, where the Erie division of the New-York rocks prevails. Onestagra is upon the left, and is a steep escarpment of the Hamilton group. The Catskill division appears in the distance. The hills are usually steep, and furnish a scanty pasturage. It is a view in Fultonham, Schoharie county.

PLATE VII.

This is a view of the Catskill range, as it appears upon the high ground opposite the landing at Catskill. The foreground is occupied by the taconic slate; the middle by the Hudson river series, which are much disturbed, but which finally pass beneath the thin-bedded calcareous shale of the waterlimes. The back ground is occupied by the Catskill division, which exhibits many red and green strata, with their slates intervening, but rarely contains fossils. The New-York system is here crowded into a very narrow space, and dips rapidly beneath the Catskill mountains. The base of the mountains is gained by passing over a succession of narrow terraces. The mountains themselves are deeply cleft by the northern diluvial current, which must have pressed with great force and power upon the most advanced of the outlying hills of the Catskill. It is at this point that this great current, with its burthen of stones, is deflected to the east.

PLATE VIII.

Is designed to give a semi-panoramic view of the valley and hills of the Schoharie. The middle of the back ground is formed of the Helderberg division, mainly: at the junction of the valley with the hills the Hudson river group ceases, and the Helderberg division begins. The Ontario division is also unknown here, or may, perhaps, be feebly represented by a series of thin-bedded dark colored shales. At the west, beyond the main bluff, the Cobleskill enters into the valley of Schoharie. The Erie division appears upon the left, and the Champlain upon the right. The vallies and hill-sides are valuable and productive lands.

PLATE IX.

The Genesee river, at and below Rochester falls, has excavated a deep channel in the soft shales for a considerable distance below the city. As usual, however, the hard bands of rock resist the process of excavation until they are undermined, when they fall of their own weight, or yield to the pressure of circumstances. These hard bands, however, create cascades and water-falls more or less imposing. Two falls are thus created at or near Rochester, and are usually known as the Upper and Lower falls. The view is that of the Upper falls. The hard band in this instance is the Niagara limestone, and the thin band calcareous layers immediately below it. The view was taken on the east side, at the turn in the pathway about eighty rods below the falls.

PLATE X.

The American falls are seen to the best advantage upon the Canada side. We look down upon the deep gulf, occupied by forest trees of many kinds, beyond which the cataract appears. The geological formations belong to the Ontario division.

PLATE XI.

On the west side of the creek at Schoharie the Catskill range rises in the distance, and at the south. The meadows and flats appear immediately beneath the foreground, and the creek bathing the base of the western hills.

PLATE XII.

Exhibits a view of the Schoharie valley and creek at Gilboa, twenty-five miles above Schoharie court-house. The rocks belong to the Catskill division, and contain many fossils, but of vegetables and mollusca, the latter belonging mainly to the genus *Cypricardia.* The peculiar vegetation of the vallies is well exhibited; the pendulous elm, and the spreading butternut. The rocks dip only moderately to the southwest. The hills are quite steep, and are only thinly covered with grass.

PLATE XIII.

Is designed to illustrate some of the topographical features of the Taconic system. For this end I selected Graylock, the highest ground in Massachusetts. Short abrupt ranges seem to have been forced upward, and even appear as if they had been subsequently broken down. In the middle ground the first range is broke down so as to expose the steep slope from Graylock in the distance, into what is called the Hopper. One of the branches of the Hoosic river rises in these narrow gorges. Graylock commands an extended view over the eastern part of New-York, including a part of the Hudson valley and the Catskill ranges.

PLATE XIV.

Fig. 1. *Nemapodia tenuissima.* E. This remarkable impression upon the slate of Washington county, has been shown, I think very satisfactorily, by my friend Dr. Fitch, to be formed by some living unknown animal.

Fig. 2. *Gordia marina.* E. Body linear, smooth, compressed; convolutions or folds like the *Nereites.* The animal seemed to be destitute of knots or ganglia. It occurs in the quarries of flagging stone in Jackson, Washington county.

Fig. 3. This is a fragment merely of a crustacean of a doubtful character, or it may be a part of a nereite. It was the first fossil which was found in Washington county, which belonged to the animal kingdom.

PLATE XV.

Fig. 1. *Nereites jacksoni.* E. Feet large and orbicular: Waterville, Me.

Fig. 2. *N. pugnus.* E. Feet large, rather long and ovate. It terminates in an enlargement which resembles the fist. See fig. 4, Plate 16. Waterville, Me.

Fig. 3. *N. loomisi.* E. Feet numerous, small, lanceolate: Waterville, Me.

PLATE XVI.

Fig. 1. *Myrianites murchisoni.* E. Long, linear or threadform, and slightly knotted; folds numerous.

Fig. 2. *Nereites deweyi.* Feet oval, numerous.

Fig. 3. *N. gracilis.* E. Feet narrow, thickly implanted; long, ovate.

Fig. 4. *N. pugnus.* Showing the termination.

Fig. 5. *M. sillimani.* E. The body is larger than the *M. murchisoni*, but the knots are quite similar to it.

Fig. 6. *N. lanceolata.* Feet lanceolate.

PLATE XVII.

Exhibits the pelagic fucoids of the roofing and taconic slates of Rensselaer and Washington counties.

PLATE XVIII. (TACONIC SYSTEM).

SECTION 1. The valley of the Hudson is formed at Fort-Edward by the Hudson river series. The hills bordering the valley are often crowned, as represented in the plate, by the calciferous sandstone, beneath which we invariably find the taconic slate. The calciferous sandstone is usually an outlier, and is really an insulated mass. Proceeding eastwardly, the slate is known to contain beds of grit and sometimes calcareous strata, which are usually, if not always, thin-bedded and without fossils. The thick and heavy beds of limestone are found only towards the base of the Green mountain range. The granular quartz, or brown sandstone, is the most eastwardly rock of this system, and rests, in this section, on gneiss. The drift obscures the relations of these rocks towards Sunderland, but there is no doubt respecting the superposition of the granular quartz. This section may be regarded as one of the best for exhibiting and proving the entire independence of the Taconic system from the Primary below and the New-York system above.

SECTION 2. This section furnishes some facts of an interesting kind. The bordering ridge of the Hudson valley is crowned, east of Greenbush, with a mass of calciferous sandstone, which abounds in its peculiar fossils; but the superior part of the limestone is the Trenton, which finally passes into a black slate, which also contains fossiliferous layers of limestone; so that we are furnished at this point with slate above identical with the Trenton slate, and also slate below identical with the Taconic slate. None but prejudiced geologists will have the hardihood to maintain that the slate beneath the calciferous sandstone is equivalent to the Trenton or Utica slates, or the slates of the Hudson river group; or that the series has been reversed or overturned. Upon this section the Hudson river group recurs, beneath which lie the taconic slates. At Chatham four-corners, the taconic, or perhaps more properly the magnesian slates emerge from beneath the Hudson river group which appears about a mile west, the intervening space being filled with drift.

SECTION 3. The west end, at Whitehall, exhibits the lower rocks of the Champlain division resting upon gneiss. The former are deeply cleft by diluvial action. The taconic slates appear for the first time about three miles to the east, and in many places in this region they support the outlying masses of the calciferous sandstone. The section extends between five and six miles east of Whitehall.

SECTION 4. This section exhibits nearly the same phenomena and geological relations as the preceding.

SECTION 5. This short section is designed to exhibit the relations of the superior mass of the Hudson river group to the taconic slates. The thick bed, however, is succeeded by a thin-bedded slate. The thin-bedded limestones occur a few miles from Bath on this section.

SECTION 6. At Poughkeepsie taconic slates appear in the steep bluffs which line the banks of the river. At Milton, about one mile west of the landing, the Hudson river group appears, and contains the common fossils of the series. The dip is changed in this case to the east. The layers are closely packed, and the fossils consequently are obscure.

PLATE XIX.

PLATERSKILL CLOVE. It is a deep cut in the Catskill mountains, through which there is merely space for a road. The view is eastwardly, and looks out upon the Hudson valley, in which the river may be seen threading its silver way to the Highlands. Beyond, the Taconic ranges rise and meet the horizon in elevated panoramas. The rocks which appear in the notch or clove, belong to the Devonian series, and lie in horizontal position. They have been cut down nearly a thousand feet by diluvial action. Numerous primary and foreign boulders are lodged in this narrow passage, and show conclusively the transporting agents which have been at work in ancient times.

PLATE XX.

The middle section, or section 1 of Plate 20 and 21, is an east and west section, and extends from the Hudson to Lewiston. Although not drawn in a direction perpendicular to the strike of the rocks, yet it shows very satisfactorily the thinning out of the strata as they extend westward from the Helderberg range. The Ontario division here is absent, while the Helderberg is supposed to be fully represented. Westward, and near Little falls, the Ontario division again appears. At the eastern extremity of the section the Helderberg and Erie divisions are prominently exhibited. In the central counties, the Salt group forms the superior mass; while at the extreme west, the Ontario division occupies the surface.

Section 2, Plate 20, exhibits the position and succession of rocks at Schoharie. This section is designed also to illustrate the fact that the valley was formed by denudation.

Section 3. The High falls of Rondout, in Ulster county, show a singular derangement of the strata, which resulted in fracturing them at least three times in a very short distance. The river falls over a rock which seems to be equivalent to the pentamerus limestone, or a mixture of this with the delthyris shaly limestone.

Section 4. The Limestone creek, at Manlius, passes through a gorge and over a ledge of limestone. The superior rock, or that which forms the hills on the east and west side of the village, is the Marcellus slate.

Sections 5 & 6. Exhibit remarkable flexures of the strata. Arches, curves and fractures are constantly recurring between Catskill and Leeds. West of Leeds, the rocks are only slightly disturbed. The best route for observing the numerous changes of dip, etc., is the old railroad between the above named places.

PLATE XXI.

Section 1. Is a continuation of section 1 upon Plate 20.

Section 2. The uninterrupted succession of the lower sedimentary rocks of the New-York system, on a north and south line beginning at Theresa and terminating at Auburn, is a very satisfactory exhibition of stratigraphical succession. It exhibits the relative position of the Ontario division.

Section 3. The turnpike route from Catskill to Gilboa exhibits the great scale upon which the Catskill division is developed in New-York. The superior mass of the Catskill mountains is undoubtedly the conglomerate of the Carboniferous series or system: it is colored purple.

Section 4. This section follows up a creek which falls into the Cayuga lake at Auburn; the regular succession only is intended to be indicated.

Section 5. This section runs north and south, and is intended to exhibit the succession of rocks upon Cayuga lake.

EXPLANATION OF THE ENGRAVINGS.

PAGE 33. *View of the Adirondack Pass.* This view is designed to give an idea of the immense mural precipice about five miles from the Adirondack iron-works in Newcomb, Essex county. It rises one thousand feet above the observer at its base, and is a grand exhibition of an uplift in this Primary region. The rock is the hypersthene rock. The fragments, which have fallen at different times, are thirty feet high, and support living and growing trees as high as themselves. The Ausable, which flows into the Gulf of the St. Lawrence, rises on one side; and the Hudson, which flows into the Atlantic at New-York, on the other.

PAGE 75. This cut exhibits a portion of the Taconic range upon its eastern side. It forms a continuous range, but made up of a succession of rounded eminences. These hills may be cultivated to their tops; but they are devoted to pasturage. The view is from the south end of Stone hill in Williamstown (Mass.), looking southwest.

PAGE 171. The view shows the thin and imperfectly bedded Cauda-galli grit in its horizontal position, as it is cut through by a creek at New-Scotland.

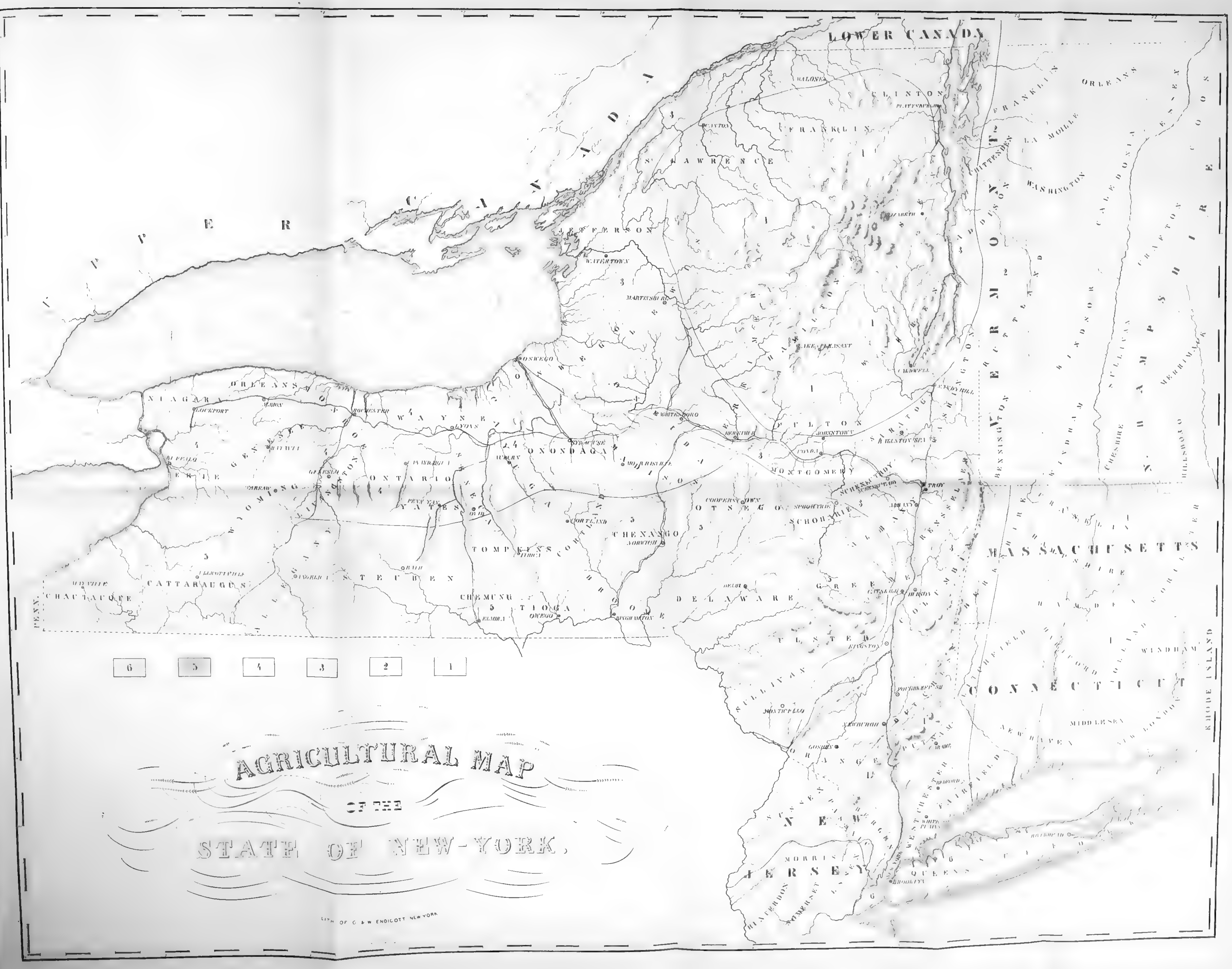
The cut on page 172 shows the effect upon the same rock, when it has been subjected to pressure, and slightly elevated and weathered. It appears to have been raised to a vertical position, and would be thus regarded, perhaps, were it not that fossils have been found upon the layers, which dip very slightly. The locality is the gorge near Leeds.

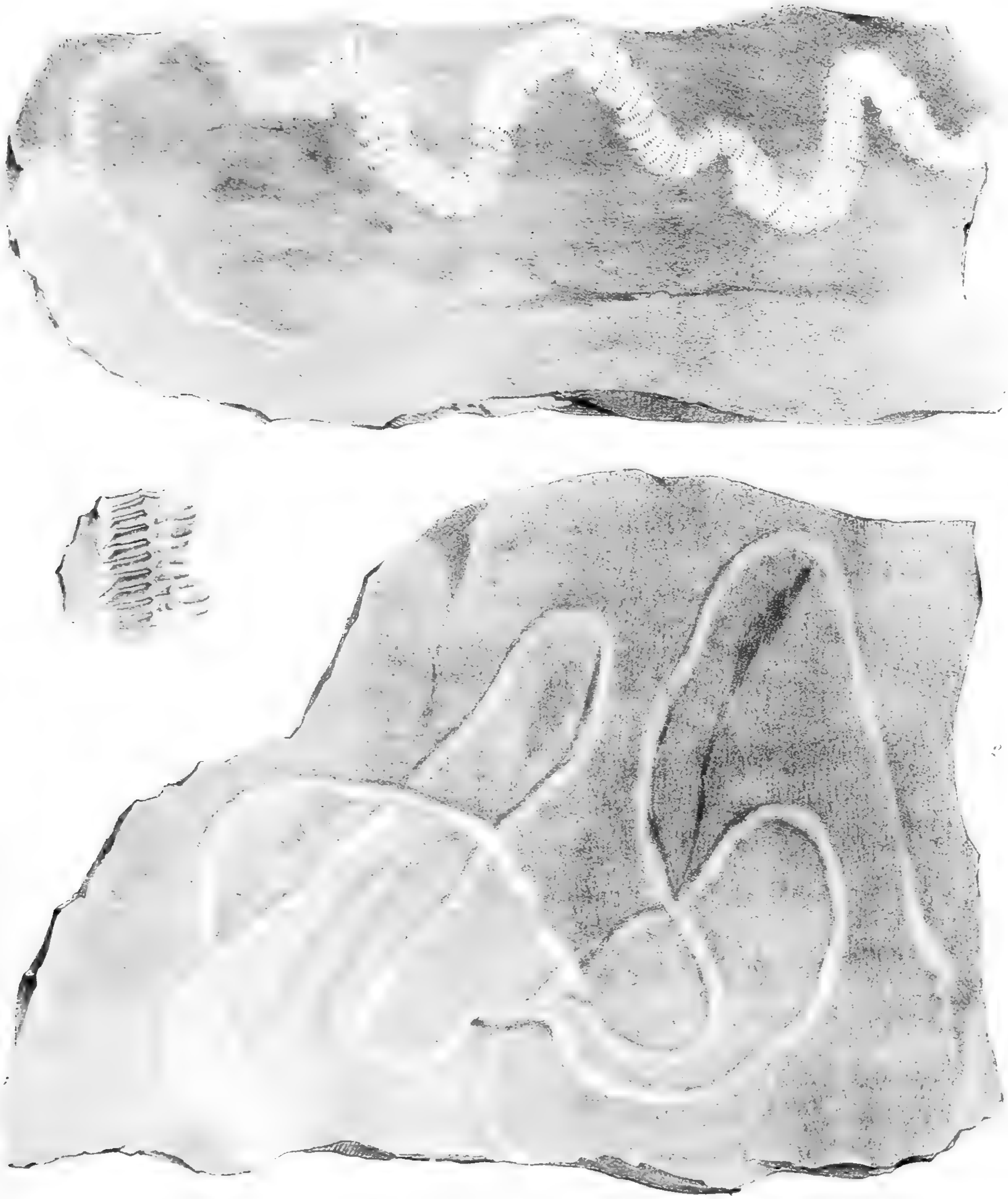
PAGE 187. Exhibits one of the many waterfalls which occur in the New-York system. The rock belongs to the upper part of the Hamilton group, and the fall is formed by a small rapid stream near Summit in Schoharie county. The rock is thin-bedded, and it has made a remarkably fine exposure of this group, which is quite interesting for the abundance of its fossils.

PAGE 192. The view looks up the Schoharie creek at Gilboa. The valley is narrow, and bounded by ranges of hills and mountains which project into it. The rocks are horizontal, and have been cut out by diluvial action, and thus opened the valley for the present creek. This is evident, from the fact that the rocks are scored in the direction of the valley at different heights above the present stream.

PAGE 306. The natural vegetation of the hills of the Southern district is represented in this cut. The trees are thickly planted: tall and intermixed maples, pines, hemlocks and beeches, are the most conspicuous. It is a view in Gilboa, but resembles a hundred others in the same range of hills.

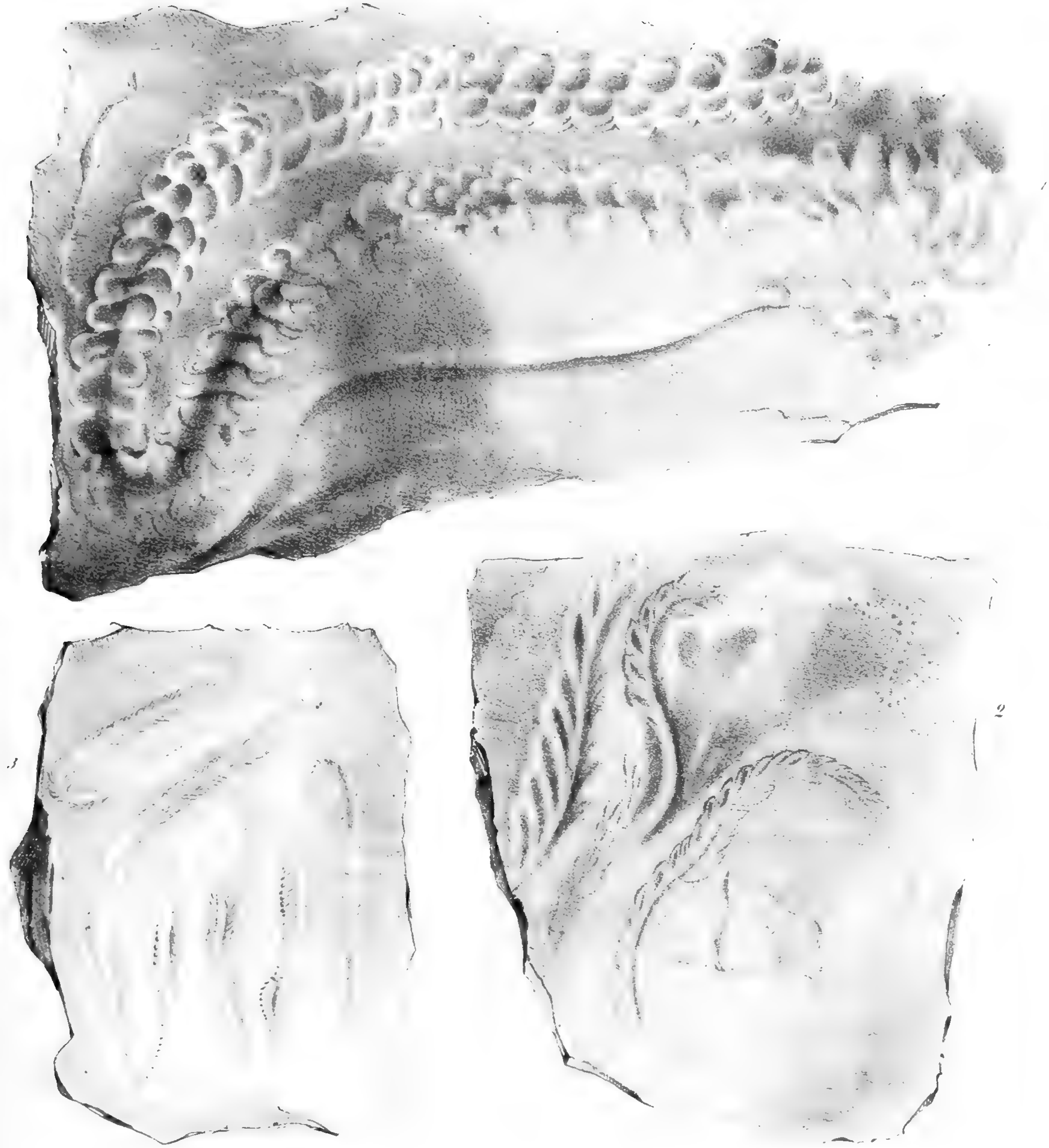
INDEX.


AGRICULTURAL MAP
OF THE
STATE OF NEW-YORK.
LITH. OF G. & W. ENDICOTT NEW YORK
6
5
4
3
2
1
LOWER CANADA
UPPER CANADA
JEFFERSON
WATERTOWN
MARTINSBURG
OSWEGO
NIAGARA
ORLEANS
LOCKPORT
ROCHESTER
WAYNE
LYONS
ONONDAGA
SYRACUSE
ERIE
BUFFALO
WYOMING
ONTARIO
YATES
TOMPKINS
CHENANGO
NORWICH
CATTARAUGUS
CHAUTAUQUE
STEUBEN
BATH
CHEMUNG
TIOGA
ELMIRA
OWEGO
BINGHAMTON
DELAWARE
DELHI
OTSEGO
COOPERSTOWN
SCHOHARIE
MONTGOMERY
FULTON
JOHNSTOWN
SCHENECTADY
TROY
ALBANY
HUDSON
CATSKILL
KINGSTON
SULLIVAN
MONTICELLO
NEWBURGH
POUGHKEEPSIE
GOSHEN
BROOKLYN
QUEENS
MALONE
CLINTON
PLATTSBURGH
FRANKLIN
ST. LAWRENCE
LAKE PLEASANT
CALDWELL
ELIZABETH
VERMONT
BENNINGTON
WASHINGTON
ORLEANS
CALEDONIA
WINDSOR
WINDHAM
NEW HAMPSHIRE
CHESHIRE
SULLIVAN
MASSACHUSETTS
CONNECTICUT
MIDDLESEX
NEW HAVEN
WINDHAM
RHODE ISLAND
NEW JERSEY
MORRIS
SOMERSET
HUNTERDON
PENN.



1 Nemapedia tenuissima
2 Sordia marina

PLATE XV



ENDICOTT LITH.

1 *Nereites Jacksoni.*
2 *N. pugnus*
3 *N. Loomisi.*

PLATE XVI

ENDICOTT LITH.

1. Myrianites Murchinsoni

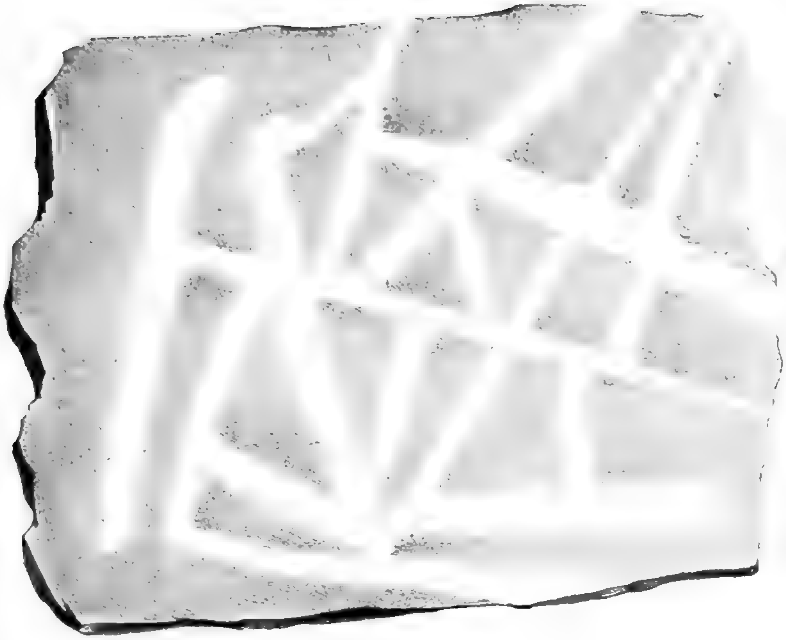
2. Nereites Deweyi.

3. N. gracilis

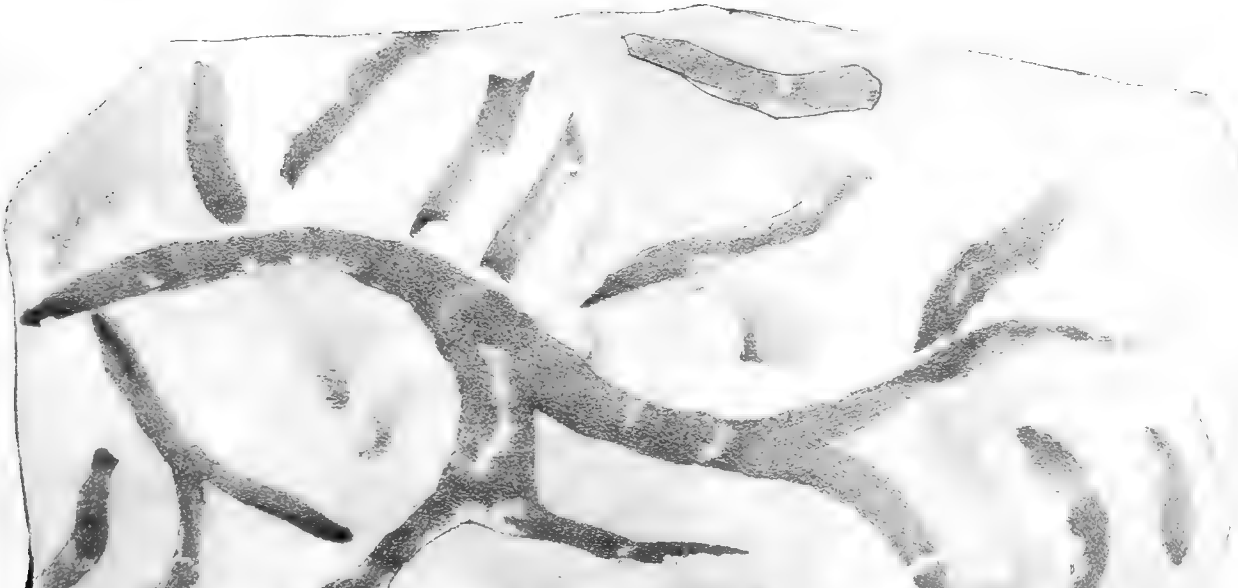
4. N. pugnus

6. N. lanceolata.

5. Myrianites Sillimani

1


2


3


ENDICOTT LITH

1 *Fucoides simplex.*
2 " *rigido*
3 " *flexuosa.*

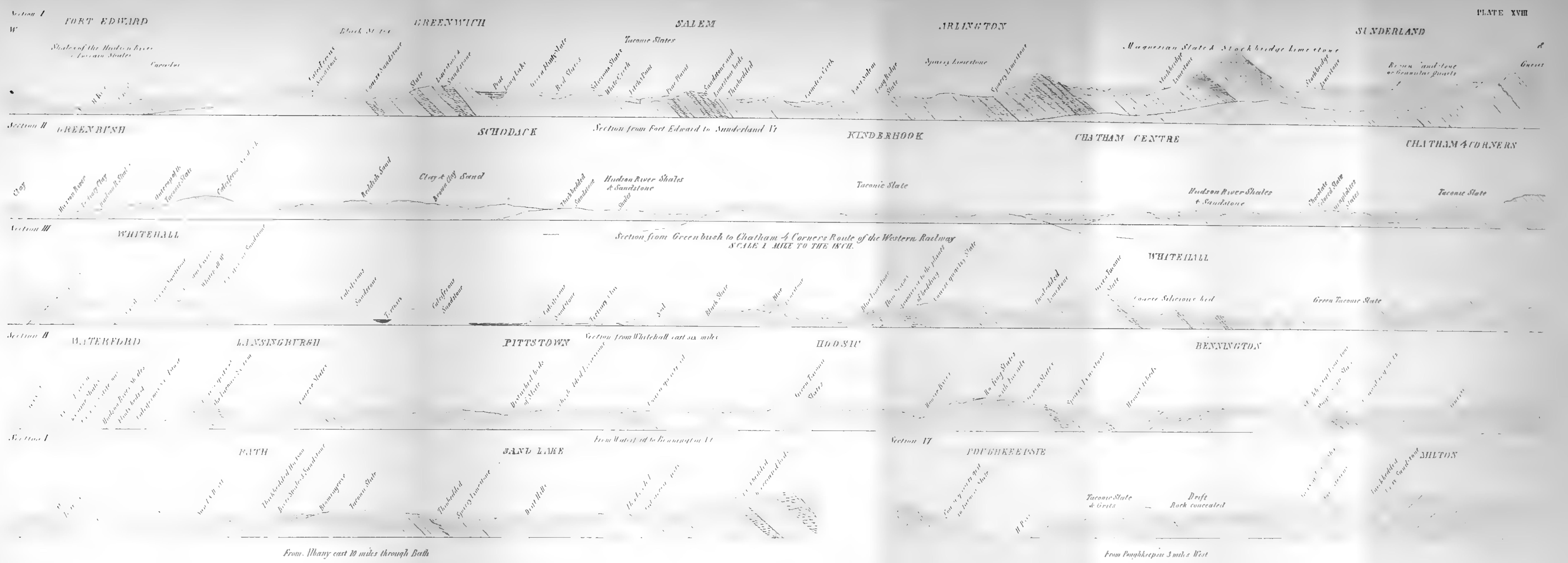
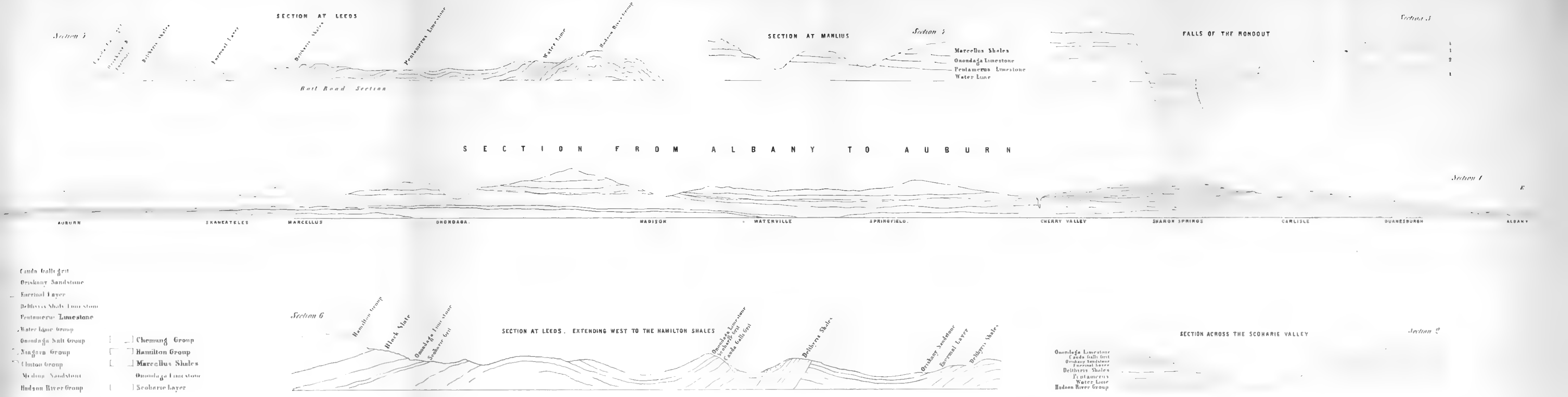
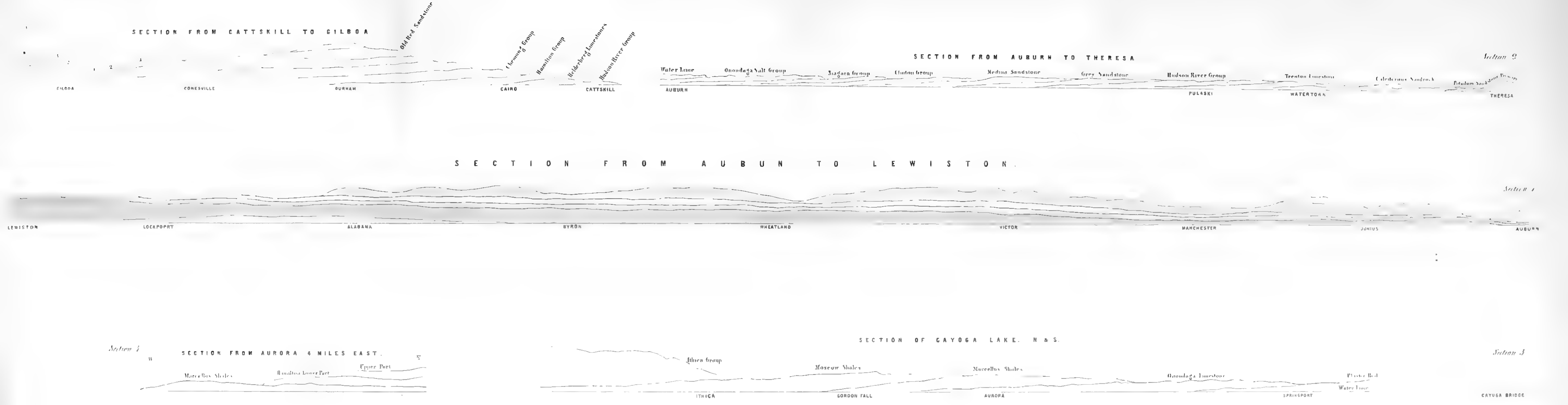

Section I
FORT EDWARD
GREENWICH
SALEM
ARLINGTON
SUNDERLAND
Taconic Slates
Section from Fort Edward to Sunderland Vt
Section II
GREENBUSH
SCHODACK
KINDERHOOK
CHATHAM CENTRE
CHATHAM 4 CORNERS
Clay & Clay Sand
Hudson River Shales & Sandstone
Taconic Slate
Section from Greenbush to Chatham 4 Corners Route of the Western Railway
SCALE 1 MILE TO THE INCH.
Section III
WHITEHALL
Coarse Silicious bed
Green Taconic Slate
Section from Whitehall east six miles
WATERFORD
LANSINGBURGH
PITTSTOWN
HOOSIC
BENNINGTON
BATH
SAND LAKE
Section V
POUGHKEEPSIE
MILTON
Taconic Slate & Grits
Drift
Rock concealed
From Albany east 10 miles through Bath
From Poughkeepsie 3 miles West

Plate XX



SECTION AT LEEDS
Section 5
Rail Road Section
Delthyris Shales
Encrinal Layer
Pentamerus Limestone
Water Lime
Hudson River Group
SECTION AT MANLIUS
Section 4
Marcellus Shales
Onondaga Limestone
Pentamerus Limestone
Water Lime
FALLS OF THE RONDOUT
Section 3
SECTION FROM ALBANY TO AUBURN
Section 1
AUBURN
SKANEATELES
MARCELLUS
ONONDAGA
MADISON
WATERVILLE
SPRINGFIELD
CHERRY VALLEY
SHARON SPRINGS
CARLISLE
DUANESBURGH
ALBANY
Cauda Galli Grit
Oriskany Sandstone
Encrinal Layer
Delthyris Shaly Limestone
Pentamerus Limestone
Water Lime Group
Onondaga Salt Group
Niagara Group
Clinton Group
Medina Sandstone
Hudson River Group
Chemung Group
Hamilton Group
Marcellus Shales
Onondaga Limestone
Scoharie Layer
Section 6
SECTION AT LEEDS, EXTENDING WEST TO THE HAMILTON SHALES
Hamilton Group
Black Slate
Onondaga Limestone
Scoharie Grit
Cauda Galli Grit
Delthyris Shales
Oriskany Sandstone
Encrinal Layer
SECTION ACROSS THE SCOHARIE VALLEY
Section 2
Onondaga Limestone
Cauda Galli Grit
Oriskany Sandstone
Encrinal Layer
Delthyris Shales
Pentamerus
Water Lime
Hudson River Group


SECTION FROM CATTSKILL TO GILBOA
Old Red Sandstone
Chemung Group
Hamilton Group
Helderberg Limestones
Hudson River Group
GILBOA
CONESVILLE
DURHAM
CAIRO
CATTSKILL
SECTION FROM AUBURN TO THERESA
Section 2
Water Lime
Onondaga Salt Group
Niagara Group
Clinton Group
Medina Sandstone
Grey Sandstone
Hudson River Group
Trenton Limestone
AUBURN
PULASKI
WATERTOWN
THERESA
SECTION FROM AUBUN TO LEWISTON.
Section 1
LEWISTON
LOCKPORT
ALABAMA
BYRON
WHEATLAND
VICTOR
MANCHESTER
JUNIUS
AUBURN
Section 4
SECTION FROM AURORA 4 MILES EAST.
Marcellus Shales
Hamilton Lower Part
Upper Part
SECTION OF CAYOGA LAKE. N & S.
Section 3
Ithaca Group
Moscow Shales
Marcellus Shales
Onondaga Limestone
Plaster Bed
Water Lime
ITHICA
GORDON FALL
AURORA
SPRINGPORT
CAYUGA BRIDGE