MESSAGE

FROM

HIS EXCELLENCY THE GOVERNOR GENERAL,

WITH

REPORTS

ON A

GEOLOGICAL SURVEY

OF THE

PROVINCE OF CANADA,

PRESENTED TO THE HOUSE ON 27TH JANUARY, 1845.

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY.

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1845.

C. T. METCALFE.

THE GOVERNOR GENERAL transmits for the information of the Legislative Assembly, the accompanying Copies of Rports that have been received from Mr. W. E. LOGAN, who is employed on a Geological Survey of the Province.

GOVERNMENT HOUSE,
Montreal, 20th January, 1845.

REMARKS

ON

THE MODE OF PROCEEDING TO MAKE

A

GEOLOGICAL SURVEY OF THE PROVINCE.

ADDRESSED IN SEPTEMBER, 1842, TO RAWSON W. RAWSON, ESQ., CIVIL SECRETARY TO HIS EXCELLENCY THE GOVERNOR GENERAL.

THE Geological investigations made within the last few years in Pennsylvania, New York, and other States of the American Union. at the expense of their Governments, have thrown great light upon the structure of a considerable portion of the country lying between the Rocky Mountains and the Atlantic Ocean; and it would seem that a vast trough of deposits, conformable from the coal downwards, extends longitudinally from Alabama to some point below Quebec on the St. Lawrence, and transversely from the shores of Lake Huron to the borders of the Atlantic.

Confining attention to those regions, which serve to illustrate the probable structure of Canada, it would appear that a nucleus of coal measures coming from the southwest is spread out in Pennsylvania, and that from the southwest corner of this State these measures extend more than 200 miles in a north-east direction, while their greatest breadth, from within a few miles of Lake Erie to the Apalachian range of mountains, may be about 120 miles. From beneath this enormous coal-field, there crop out in succession a variety of conformable deposits, which roughly follow its contour in parallel bands, and among them, at a distance of more than 20,000 feet below the coal, as measured on the south-eastern side of the trough, is a well marked limestone formation, supposed from its fossils to be contemporaneous with the lower silurian rocks of Britain. This, in its south-eastern development, passes from the State of Pennsylvania to that of New York, and, reaching the banks of the Hudson River and Lake Champlain, sweeps into Canada, in the eastern section of which it constitutes the trough of the St. Lawrence, forming the banks of the river to some distance below Quebec. Returning from this, its northwestern outcrop touches the north shore of Lake Ontario, and passing to the south of Lake Simcoe,* strikes upon Lake Huron.

This limestone rests upon a deposit of sandstone of considerable thickness, and I am inclined to think that in the western section of the Province, and on the northern bank of the St. Lawrence in the eastern section, these two formations are generally succeeded by primary and granitic rocks, which extend to a great distance northward, while in the Eastern Townships, of the eastern section, they rest upon clay slate.† In that part of the country which lies between Lake Ontario and Lake St. Claire, it is probable that several of the formations occupying the space between the limestone above mentioned and the coal will be found; among them being one which in the State of New York is said to bear valuable beds of gypsum.

If this general view of the structure of the country should be confirmed by such a hasty reconnaissance as can be made during the present season, it appears to me that a judicious mode of bringing out the details of its Geology would be, to make several parallel sections in a northward and southward direction, the number and locality of which must be determined by circumstances. These would fix with accuracy the boundaries of the various deposits at certain points, and by intermediate examinations the continuous direction of the lines of outcrop could be ascertained.

It is, I believe, upon the secondary rocks enumerated that the chief part of the settlement of the country exists. The primary rocks, however, most of which are still covered with forest, will probably constitute the metalliferous portion of Canada. To what

* On examination it has been found that the formation passes under the northern half of Lake Simcoe.

† Further investigation tends to prove that this clay slate is of more recent origin than the limestone, and occupies a position over, instead of under it.

distance upon these it will be judicious to carry the sections and examinations is a subject that will require consideration. It will probably be prudent in the first instance to proceed but a short distance beyond the limit of settlement, until so much of the general survey is completed as will be sufficient to determine with truth the prominent geological features of the country, and so connect them together as to form the foundation of a more extended or more elaborate investigation subsequently, should the Legislature deem it expedient to permit the present Survey to continue sufficiently long for the purpose, or institute a similar one at a future period.

The proposed mode of proceeding to examine the geological structure of the country will be perfectly efficacious in obtaining a correct general knowledge of its mineral riches, which, no doubt, is the first and main object to be attended to in the investigation. It will be essential for true sections to contain these mineralogical details, and they can be ascertained as the examination proceeds, to that degree of minuteness to which a due attention to an economy of time and means may permit the adoption; while there is no contemplated object of the Survey that may not be served by the plan in question, whether it be to ascertain the existence of rocks that may afford good materials for building or ornamental purposes, or for the repairs of roads; of mineral springs, of substances fit for manufactures or manures; or of new minerals; or to make collections of specimens to be placed in public institutions for the elucidation of the whole subject.

It would materially assist the attainment of a rapid reconnaissance, if answers could be obtained to the following questions, from as great a number of persons in the country as are likely to have observed the facts to which they relate.

QUESTIONS.

What is the locality of any limestone in your neighbourhood, or other place that you are aware of, in regard to some known river or lot of land, and over what extent of country does it spread?

Is it divided into beds?

Do the beds lie flat, or to what point of the compass do they slope, and at what inclination to the horizontal plane?

Are there any organic remains or shells in it?

What is its color and texture?

Does it make good lime?

Will the lime set in water?

Where is there any sandstone in your neighbourhood, or that you know of?

Are the beds flat, or to what point of the compass do they dip or slope, and at what inclination to the horizon?

Is it a free-stone?

Is it fine or coarse grained, or are there any pebbles enclosed in it, and of what size are the pebbles?

Can you state the exact locality of any plaster or gypsum beds, or of any salt springs?

What kind of rocks are near them, and how near them?

Can you state the locality of any iron ore?

Is it bog or mountain ore?

Do you know the locality of any veins of lead or copper ore?

What is their thickness, and in what direction do they run?

Do you know the locality of any coal in the country?

Are there any great masses of rock in your neighbourhood, and what is the locality and quality of them?

Can you procure specimens of ores or rocks or fossils, and state the locality whence they come?

PRELIMINARY REPORT,

ADDRESSED TO

RAWSON W. RAWSON, ESQUIRE,

Civil Secretary to His Excellency the Governor General.

MONTREAL, *6th December*, 1842.

SIR,

Unfulfilled professional engagements, contracted in Britain previous to my undertaking a Geological Survey of this Province, rendering it necessary that I should avail myself of the permission accorded by His Excellency the Governor General to pass the winter on the other side of the Atlantic, I am desirous, before my departure to state, for the information of His Excellency, in how far it may be considered the Survey in question has been advanced by my present visit to Canada.

This visit I am disposed to regard merely as preliminary and preparatory to a vigorous and systematic entrance upon the duties of my task next season, after a mature consideration of the information and materials now collected shall have enabled me to recommend for adoption such a plan of investigation as may promise to lead to the most speedy and economical development of the mineral riches of the country; and when attention is given to the wide expanse of surface to be examined, which, stretching from the North Western shore of Lake Superior to the mouth of the Great River that unwaters the whole area, spreads across twenty five degrees of longitude and ten of latitude, and comprises in the mere narrow strip partially settled along the River and its Lakes upwards of 60,000 square miles, the advantage and absolute necessity of a judicious and systematic plan of operations, so as to attain a satisfactory result in a reasonable time, are too obvious to be insisted on.

In forming such a plan, my presence in Britain will, I am persuaded, be of essential service to the Survey, as it will give me an opportunity of ascertaining the opinions of some of her leading geologists on the subject. Among others, I shall have pleasure in addressing myself to Sir Henry T. De la Beche, who so ably directs the Ordnance Geological Survey of that country, and who, taking a deep interest in the investigation instituted in Canada, has in the handsomest manner offered to make the scientific force of his staff available in the analysis of Canadian minerals and the comparison of Canadian fossils, should any difficulty arise in their examination here. I hope also to obtain the suggestions of Mr. Lyell, whose recent visit to the New World having given him an opportunity of closely studying the results arrived at in the Geological Surveys appointed by their Legislatures in various States of the American Union, and of subsequently comparing these with the labours of Dr. Gesner and others in New Brunswick and Nova Scotia, will give his opinions a peculiar value in regard to the structure of both extremes of the Province, while these opinions will still further be enhanced by the personal inspection he bestowed on several points in Canada itself during his rapid transit through it. With a view to the formation of a systematic plan of operations, my efforts on my arrival here were directed not so much to personal examination as to the collection of such information as might already exist in the country, in public documents and reports, in contributions to the transactions of scientific Societies, or in the possession of such of the inhabitants as might have devoted observation to geological facts in districts immediately surrounding them; and considering that the meeting of the Legislature in the commencement of September, when so many persons of intelligence might bring contributions from different and distant localities, would afford a valuable opportunity for concentrating the floating knowledge bearing on the subject, I was induced to remain some time at the Seat of Government to avail myself of it. I was enabled at the same time to form a collection of such maps of the country as were within the controul of the various departments of the Government, and to have them mounted and prepared for service in the field. For these my thanks are due to the Provincial Secretaries, the Surveyor General, the Commissioner of Crown Lands, the President of the Board of Works, and others. But among the documents which have come into my hands, I have especially to express my obligations to His Excellency the Governor General for the published reports he has been instrumental in procuring for me on the Geology of various States bordering on Canada.

The value of these reports cannot be over-rated, and the study of them will tend to save a vast amount of labour and difficulty in the geological investigation of the Colony. The final reports of the surveys accompanied by maps, geologically coloured, have not yet been placed before the world, and though the want of such maps often renders it tedious and perplexing to trace out with accuracy the range of the formations described, enough is already given to teach a geologist what succession of rocks he has to search for in this portion of North America, and what subordinate mineral contents he may expect them to possess. Their range too is generally indicated sufficiently, where they abut upon the shores of the lakes and rivers that separate the two countries, to enable him to conjecture at what point they may strike into Canada, and were some one member of the series of deposits, well marked by its organic contents, accurately traced through the Province, a few general tranverse sections would in as short a time as is practicable bring out the main features of Canadian Geology.

From the labours of the American geologists, as detailed in these reports, it would seem that a gigantic trough of transition deposits, conformable from the carboniferous era downwards, extends longitudinally from Cape Tourment below Quebec to some point beyond Alabama in the Southern States, and transversely from the northern shores of Lake Huron, to within no very great distance of the borders of the Atlantic Ocean.

Confining attention to those regions which more immediately serve to illustrate the probable structure of Canada, it appears that a nucleus of coal measures coming from the south west is greatly spread out in Ohio and Pennsylvania. That portion of the deposit which belongs to Pennsylvania alone extends in an unbroken body from the south west corner of the State, a distance of 200 miles in a north east direction, while it occupies a breadth of 120 miles, from within twelve leagues of Lake Erie to the Apalachian range of mountains. Its line of contour exhibits on the North East a number of salient portions, pointing like fingers in that direction, and separated from one another by the effect of a series of parallel anticlinal axes, along which have been worn deep valleys in the various soft deposits below.* These salient portions in the carboniferous outcrop are therefore minor coal troughs subordinate to the great one, and though as parts of the great unbroken body of the deposit they reach no further than the road between Buffalo and Philadelphia, there continues from the extremity of each a series of outlying patches resting on sinclinal mountain-tops, which in some cases run quite across the State and enter that of New York. The most eastern out-lier is the anthracite coal region of Wyoming, the position of which is within 20 miles of the Delaware river, where it forms the dividing line of the two States mentioned, at the north-eastern angle of Pennsylvania.

From beneath this enormous coal-field, with all its outlying patches, there crops out in succession a variety of conformable deposits, which on the surface roughly follow the contour of their carboniferous central nucleus, in parallel belts of unequal breadth, and accommodate themselves to all the sinuosities occasioned by geological or geographical undulations.

These zones of course take a wider and a wider sweep as the deposits descend in the series, and the range of those at the base shew that the accumulated thickness of the whole must be very considerable, however flat the trough may be. As measured on the south side of the trough, this thickness has been ascertained to amount to 30,000 feet, and though it is possible several members of the series may thin down towards the north, it cannot fail to be of great amount on that side also.

The lowest of these conformable deposits consists of silicious and calciferous sandstones of variable quality, which give support to a thick and conspicuous formation of blue limestone and associated shale, well marked by its organic remains. In its southern development, this limestone has been traced across the State of Pennsylvania into that of New York, where gaining the Hudson River, it passes on to Lake Champlain and thence runs into Canada.

Having, when in this country upwards of a year past, made a considerable collection of the fossils of this formation and subsequently submitted them to the inspection of British geologists,

* See Professor H. D. Rogers' state reports on the Geology of Pennsylvania.

they have examined them with much interest, and pronounced them with some degree of cautious hesitationto be long to the lower silurian rocks of Murchison. The collection is, at present, in the possession of Mr. John Phillips of York, Palœontologist to the Ordnance Geological Survey of Great Britain, who is at this time engaged in making an extensive review of the fossils of the silurian epoch generally, and the favourable opportunity thus occurring for accurate comparison, will, it is hoped, enable him to pronounce a decided opinion on the question. But whatever be the precise equivalent of this rock in Britain, it is strongly marked by its organic remains in this country, and the formation is of a very persistant character. The surface over which it spreads in Canada is very great. Commencing at Lake Champlain, its southern margin keeps considerably to the south of the St. Lawrence. Of the distance between its outcrop and the river, however, I am, as yet, doubtful, not having, either from personal inspection or the information of others, ascertained it lower down than Yamaska, where I understand a stratified limestone answering its character is quarried for building and burning. This is about twenty-five miles from the bank of the St. Lawrence, and whatever be the distance further on, the base of the formation ultimately reaches the vicinity of Cape Tourment below Quebec.

Turning at this point, and following its northern outcrop up the St. Lawrence, it is found to run along the foot of a range of syenitic hills of a gneisoid order, which preserve a very even and direct south-western course on the north-western bank, and over the face of which various tributaries of the great river are successively precipitated in rapids and cascades, that, at once cutting deep into a thick and wide spreading deposit of an argillaceous character, (supposed from the remains of marine shells with which it is associated, to be of the most recent tertiary age,) in many places, expose the solid stratified rocks buried beneath. On the Maskinongé, the syenitic range is about twelve miles from the St. Lawrence; on the Achigan about twenty; and it strikes the Rivière du Nord about half a mile to the south of the village of St. Jerome. Following this stream down, the primary rocks, which are close on its northern bank, gradually assume a course with less of southing in it until they reach Lachute Mills, where their direction becomes nearly due west.

Along this line from Cape Tourment to Lachute, the outcrop of the limestone does not in all cases come quite up to the primary rocks. There is occasionally a space left between them for the calciferous sandstone on which it rests; and along the Rivière du Nord this rock, capped by the limestone, is seen in several places in a well defined escarpment about half a mile from the syenitic range, dipping southward at an angle of six degrees, which is probably one or two more than the average dip along the whole line of strike from the neighbourhood of Quebec.

The distance from Lachute to the exit of Lake Champlain in a straight south-east line across the upper end of the Island of Montreal is about fifty miles; and from what has been said, it would appear that the limestone under examination, from this line to the north east constitutes a shallow trough, which in the neighbourhood of Montreal is of the breadth specified, and which gradually tapering to a point, terminates at Cape Tourment, a distance of 180 miles down the St. Lawrence, which flows through the middle of it the whole way. Whether any superior rock rests upon this formation in the district described, I am not prepared to say; but from the abundant presence of limestone in the Island of Montreal, which occupies the very centre of the basin, if any does exist (and the position of a conglomerate on the Island of St. Helens renders it not unlikely) it will probably be of small extent.

Following the limestone formation to the westward, the basin which has been mentioned, after passing the line up to which it has been brought, splits into two parts against an extensive tract of primary country in the State of New York, rising up between Lake Champlain and the lower end of Lake Ontario, and passing into Canada at the Thousand Islands. Of these divisions, one arm comprehends the calcareous rock already spoken of as existing along Lake Champlain, and the other constitutes a trough, a few miles within the southern rim of which runs the St. Lawrence from the Thousand Islands to Lake St. Francis; while its northern outcrop, bordering on the Ottawa, rests upon a continuation of the syenitic range of rocks described, which, proceeding from Lachute, first touch this river at Grenville, and keep on its northern bank the whole way to the Township of Hull, with the exception of one point in the Township of Alfred, where the river making an elbow to the north, has the primary rocks on both sides. Pursuing the Ottawa against the stream, the river makes a considerable bend to the southward above the point where it thunders down the Chaudières at Bytown (a cataract inferior in importance only to Niagara,) and thus in Hull the limestone has a breadth of about five miles on the north of the river. But how much further up the stream the formation extends I have not yet ascertained, though, I believe, it is known to reach the neighbourhood of the Lac des Chats. From the Rapides des Chats to Brockville, the distance in a straight line is about seventy miles, and about ten miles to the westward of this line, the basset edge of the western extremity of the trough under description, gently rises up to rest upon the eastern side of a great promontory of syenitic country coming from the North to connect the vast primary regions of Canada, by the very narrow isthmus of the Thousand Islands, with those which spread out like a huge peninsula in New York.

Between these primary rocks and the southern outcrop of the limestone, the calciferous sandstone assuming a very silicious character, is largely developed; but on the northern side of the trough I did not any where detect it coming to the surface, though the limestone was in no place seen to approach the primary rocks so near as to determine its absence, and the lowest calcareous beds always possessed so much of an arenaceous mixture as to deteriorate the quality of the stone for the purpose of making lime. On the western side of the trough the sandstone with the limestone resting on it, is visible, among other places, at the Upper Narrows on Rideau Lake, dipping a little to the north of east at an angle of four degrees.

On the western side of the syenitic promontory which has been mentioned, the sandstone appears to thin down and die away altogether, and the limestone, which after passing round from the Hudson River by the valley of the Mohawk River and Trenton Falls, comes into Canada by Howe and Wolfe Islands, is seen at Cedar Island, in the vicinity of Kingston, to rest immediately on the syenite.

Continuing to trace this formation westward, its northern boundary from the lower extremity of Howe Island has a strike to the W. N. W., which carries it to the iron works in the Townships of Madoc and Marmora, where, cut out into promontories, peninsulas, and outlying islands, it is embossed upon the primary rocks below, and resting on which unconformably at so small an angle that, without much difficulty, it is impracticable to estimate what the average dip may be, it horizontally fills up the undulations and cavities in their surface. On closer examination it will probably be found that a similar fringe garnishes the outcrop of the deposit the whole way from the Thousand Islands, not only in the direction of Marmora, but also in that of the Lac des Chats. The top of the formation is said to strike into Canada at Newcastle, on Lake Ontario, and if such be the case, its breath to Marmora may be taken at above thirty miles.

My information as to the development of this calcareous band farther west is not very precise, but in its progress in that direction it is known to come upon the shores of Lake Simcoe, and to strike those of Lake Huron in Nottawasaga Bay. From this, taking a more northerly course, it constitutes the south-west boundary of Georgian Bay, forming Cabot's Head.* It then gains the Manitoulin and Drummond Islands, where it has been described by Dr. Bigsby, and thence reaching St. Joseph's Island, the formation terminates in Canada.

The important figure which the formation thus followed will make on the map of Canadian Geology may be estimated, when it is stated, that in this Province it is in all probability the uppermost solid rock under not much less than 30,000 square miles of its surface,† thus constituting nearly one half of that which is likely to engage the early attention of the Survey. It abounds in excellent building materials, and its quality in many places is sufficiently hard to take a high polish, and yield a good marble ; and though the geological investigations of New York do not shew it to possess any minerals of great value, it teems with excellent mineral springs of various kinds, and in general gives support to a most fruitful agricultural soil.

It will readily be understood, that the short time I have been in the country can have enabled me to extend personal observation over but a small portion of the vast tract brought into review. The main object of my excursions has been to trace, as far as pos-

* On farther investigation it is found that Cabot's Head and the Manatoulin and Drummond Islands are composed of a limestone which probably occupies a higher position in the series of deposits, and that the primary rocks of the north-eastern and northern shores of Lake Huron will probably mark the boundary of the calcareous formation mentioned in the text.

† The rocks extending immediately under this surface will probably also include the two next succeeding formations resting on the limestone.

sible, the limits of the limestone that pervades it; and though many interesting facts connected with other branches of the subject, have been ascertained, and much fossil and mineralogical material been collected, there has not yet been any opportunity to arrange the one or examine the other, with the attention due to the attainment of accurate results. The detail of these I am therefore desirous of reserving for some future occasion. My present object is to exhibit such a probable leading feature in the structure of the country, as is likely to suggest a systematic plan of operation in the Survey; and this well marked zone of limestone at the base of the transition rocks, is so far of such a character, that, its course being well ascertained, it will at once determine the direction in which to search for metals, and that in which to look for coal. Geological experience teaches that the metalliferous rocks are below it, the carboniferous above.

Dr. Buckland has remarked that, "Before we had acquired by "experiment some extensive knowledge of the contents of each "series of formations, which the Geologist can readily identify, "there was no *a priori* reason to expect the presence of coal in "any one series of strata rather than another. Indiscriminate ex- "periments in search of coal, in strata of every formation, were "therefore desirable and proper in an age when even the name of "Geology was unknown, but the continuance of such experiments "in districts which are now ascertained to be composed of non- "carboniferous strata, of the secondary and tertiary series, can no "longer be justified, since the accumulated experience of many "years has proved that it is only in those strata of the transition "series, which have been designated as the carboniferous order, "that productive coal mines on a large scale have been discovered." This observation, wherein is embodied the rule guiding the researches of Geologists for coal in the countries whose deposits have given the rule birth, and applicable to formations below as well as above the true position, is one of judicious caution to the investigators even of distant localities, where the greatest chances of a difference in condition might by some be supposed to exist. But it is brought home with peculiar force to Canada, seeing that in its immediate vicinity the geological position of the productive coal bearing formation has been clearly ascertained and the relations it bears to the rocks that strike through the Province have been accurately determined. The Geological Surveys of New

York and Pennsylvania demonstrate that the profitable coal measures exist at a certain point above the calcareous formation which here spreads out so vastly; and the geographical position of this being once fixed, it will be by transverse sections in the direction of its dip that we shall gradually approach to coal; but in consequence of the small removal from horizontality the limestone in so many places exhibits, the lineal superficial distance between the two formations will probably be very considerable. Judging from the conditions of the deposits occupying the interval, as developed in the bordering country, they will afford sand-stones for building, hydraulic limestones, gypseous marl and pure gypsum, brine springs, fossilliferous iron ore, and various other materials of high importance to agriculture, and useful in the arts. In the primary rocks below the wide-spreading limestone described we may anticipate the occurrence of the magnetic oxide of iron in very great abundance, the existence of plumbago and the presence of the ores of copper, lead, and zinc.

The labours of Captain Bayfield, Dr. Bigsby, Capt. Baddely, Dr. Wilson, Mr. Green, and others, shew that the primary rocks form a continuous line from one end to the other of northern Canada. They constitute the northern shore of Lake Superior, and that of Huron, and coasting along the North margin of the great transition trough described, they reach Cape Tourment, whence they form the north shore of the St. Lawrence and run along the coast of Labrador.

From beneath the southern edge of the transition trough there rises an important formation of pyritiferous clay slate,* with independent planes of cleavage and deposit, which is widely spread over the Eastern Townships on the south side of the St. Lawrence. But upon this to the south of the Rivière de Famine a tributary of the River Chaudière, which joins the St. Lawrence near Quebec, there rests a fossilliferous limestone whose organic remains, as far as known, do not yet contradict its identity with the great calcareous deposit of Canada,† and I am informed that a probable continuation of this fossiliferous rock may be seen gently dipping southward on the north bank of the River St. Francis, and

* As already noted, this clay-slate is probably above instead of below the limestone, in geological position.

† If the clay-slate formation be newer than the St. Lawrence limestone the Rivière de Famine limestone will probably be newer still.

rising again on the southern side all the way from Lake Aylmer to the vicinity of Sherbrooke. If this be the case we may here have the western extremity of another great transition trough which, widening as it proceeds to the eastward, may ultimately hold within it the great coal-field of New Brunswick and Nova Scotia.

The western extremity of this, like the north-eastern extremity of the Pennsylvanian Basin, will probably be split into a number of subordinate troughs formed by parallel anticlinal axes, but the great dividing geological ridge between the two grand carboniferous areas, would, if this view be correct, be a continuation of the Green Mountains of Vermont. And though these do not appear to have any decided geological feature to represent them across the line between the St. Lawrence and the Famine they are evidently prolonged into the Eastern Townships as far as Orford Mountain, and a hill called the Carbuncle on the west side of Brompton pond, which is sufficiently to the north to carry an anticlinal axis between the two transition troughs supposed.

Of the relative age of the contorted rocks at Pointe Lévi* opposite Quebec, I have not any good evidence, though I am inclined to the opinion that they come out from below the flat limestone of the St. Lawrence; and from the description given by Capt. Bayfield of the southern shore of the river, from the vicinity of this point to Cape Rosier, it appears probable that the coast strata all the way down, are of the same epoch.

At Cape Gaspé there rests upon these a very important deposit of limestone forming cliffs upwards of 600 feet in height, and as Capt. Bayfield describes the direction of the strata along the south side of the St. Lawrence as trending very much with the shore, the limestone deposit in question ought to be found at a variable distance from the south shore of the river for a considerable distance up. It seems to me not impossible, that gradually diverging from the St. Lawrence it may ultimately be traced to a junction with the limestone of the Rivière de Famine and River St. Francis, and thus be shewn to occupy, with respect to the coal of New Brunswick, the same relative position as the western limestone does in regard to that of Pennsylvania.

* The accumulation of evidence points to the conclusion that the Point Levi rocks are superior to the St. Lawrence limestone.

The Northern outcrop of the New Brunswick coal-field, is, I believe, stated to reach Canada on the shore of the Bay of Chaleur. What the distance of its base may be from Cape Gaspé is uncertain, but even if it do not exceed twenty miles there will be space enough at a much less dip than Capt. Bayfield has given to the limestone there (25 degrees) to hold the total thickness of the various formations that may occupy the interval, even should they measure as much as their equivalents in Pennsylvania.

The Island of Anticosti, and the clusters of Mingan and Esquimaux to the north of it, as well as some narrow strips of the neighbouring main are composed of limestone, which it would be necessary to connect with the Gaspé strata. Their geographical situation might at first sight seem to place them lower in the order of superposition, the general dip of the Gaspé district being to the South, but a fold over a curvilineal prolongation of the anticlinal axis of the Eastern Townships might account for the geographical position in question.

This conjectural view of the general structure of the eastern part of Canada, is given without confidence, as the facts are yet too scanty to establish it. But it would at once be invested with a high degree of probability were the fossils of the Cape Gaspé limestone and those of the St. Lawrence deposit, on rigid comparison found to agree,* and I have been induced to bring it forward chiefly to state this circumstance, for the purpose of illustrating the very great importance of organic remains in geological investigations.

It will thus be perceived that though the wide spread limestone deposit of Canada may not be possessed of subordinate mineral contents of a character to tempt researches far beneath its surface, its importance is considerable as guiding to a knowledge of the general structure of the country, and thereby facilitating the discovery of mineral riches in other formations.

In requesting you to place the present communication before His Excellency the Governor General, I am desirous of stating that the present condition of the subject of which it treats renders it almost impossible that it should be free from error.†

* The fossils of Gaspé do not agree with those of the lower limestone, neither do those few I have seen from Anticosti.

† Whatever has turned out to be correct in this Preliminary Report has been re-embodied in the succeeding one.

My object has been to give a probable sketch of some leading feature in Canadian Geology, and if I have succeeded so far as to render more easily intelligible the merits of such a plan of future operations as a less hasty consideration of the evidences collected may finally suggest, I shall rest satisfied that my time has not been misapplied.

I have the honour to be,

Sir,

Your most obedient humble servant,

W. E. LOGAN.

REPORT OF PROGRESS

FOR THE YEAR 1843.

MONTREAL, *27th November*, 1844.

SIR,

I have the honour to request that you will place before His Excellency the Governor General, the accompanying Report on the progress made in the Geological Survey of Canada in 1843. It has been delayed until the present time in the hope of information from Britain in regard to the consumption of Lithographic stone in Europe, which I am sorry to say has not yet arrived.

I have the honor to be,
Sir,
Your most obedient humble Servant,
(*Signed*,) W. E. LOGAN,
Provincial Geologist.

Honorable D. DALY,
Provincial Secretary,
&c. &c. &c.

TO HIS EXCELLENCY

THE RIGHT HONORABLE SIR CHARLES THEOPHILUS METCALFE, BART., G. C. B., GOVERNOR GENERAL, ETC. ETC. ETC.

MONTREAL, *28th April*, 1844.

MAY IT PLEASE YOUR EXCELLENCY,

Previous to entering for the ensuing season on the field labours of the Geological Survey committed to my charge, it is proper that I should report to Your Excellency the progress made in the investigation up to the present period; and for the purpose of rendering the details that may be given on this and on any future occasion more connected and intelligible, it appears to me expedient that I should place before you a short account of the general structure of an extended area on the continent of North America of which the geological features of Canada form but a part. With a general sketch of the subject before the mind, the isolated facts, from time to time ascertained, will be the more easily remembered, their bearing and value more readily understood, and the harmonious relation of parts, which would otherwise seem confused, will be more distinctly discerned.

The liberal view of their own interests, which, during the last ten years, has induced not less than twenty of the State Legislatures of the American Union to institute investigations into the mineral resources of their respective territories, and the devoted zeal and very great skill, with which their various appointed Geologists have prosecuted the tasks committed to them, have thrown a clear light upon the structure of a vast portion of the Atlantic side of this continent; and the valuable economic and scientific results of these examinations, extending over an area exceeding half a million of square miles, are now gradually appearing before the world. They excite a high degree of interest in Europe, where comparative references are made to them with increasing frequency, and the investigation of no country on this side of the Atlantic will now be satisfactorily carried on, without deriving from them an explanation of many phenomena of otherwise difficult solution. Bordering on Canada in nearly her whole length, as the States in question do, a knowledge of their structure is indispensable to the comprehension of her geology, and I experience much gratification in acknowledging, not only the great benefits conferred by the American Surveys on the science in general but also the essential service to be derived from them in the examination of Canada in particular. In availing myself of the labours of the American Geologists to illustrate the general relations of the rock formations of the Province, it will be convenient to divide the subject into two parts, and drawing a line along the Hudson River and Lake Champlain to Missisquoi Bay and thence to Quebec, to consider the region to the west of this line separately from that on the south side of the Saint Lawrence to the east, there being certain conditions in the one that do not prevail in the other.

WESTERN DIVISION.

The western division, as connected with the Geology of Canada, may be described as a gigantic trough of fossiliferous strata, conformable from the summit of the coal to the bottom of the very lowest formations containing organic remains, with a transverse axis reaching from the Wisconsin River and Green Bay in Lake Michigan to the neighbourhood of Washington, a distance of nearly seven hundred miles; and a longitudinal one extending from Quebec in a south-westerly direction, to some point, with which I am unacquainted, beyond the Tenessee River in Alabama.* Contained within this vast trough and resulting from gentle undulations in the strata, giving origin to broad anticlinal forms, there are three important subordinate basins, in the centre of each of which spreads out an enormous coal-field. One of these extends in length from the County of Logan on the southern borders of Kentucky, in a north-westerly direction to the Rock River in Illinois, where it falls into the Mississippi, a distance of three hundred and sixty miles, and in breadth from the mouth of the Missouri to the County of Tippecanoe, on the Wabash in Indiana, two hundred miles. Presenting an oval form intersected by the River Illinois, Wabash and Ohio, and bounded by the Mississippi, which sweeps along nearly the whole of its western margin, this coal-field covers an area of 55,000 square miles. The second occupies the heart of the State of Michigan, and reaching 100 miles in an east and west direction from within thirteen leagues of the Lake of that name to Saginaw Bay in Lake Huron, and 150 miles in a north and south line from the neighbourhood of the Rivers Manistee and Ausable, to the source of the Grand River near Jackson, on the road between Detroit and St. Josephs, it exhibits an irregular pentagonal shape and comprises a superficies of 12,000 square miles. The third carboniferous area stretches longitudinally about 600 miles in a north-easterly course from the state of Tenessee to the north-eastern corner of Pennsylvania, where many outlying patches belong to it, and 170 miles transversely from the north branch of the Potomac in Maryland, to the south-eastern corner of Summit County in Ohio, just twelve leagues south of Cleveland on Lake Erie. It possesses a sinuous

* See the geological Map of the Middle and Western States, lately published by James Hall, Esq., one of the State Geologists of New York.

subrhomboidal form and spreading over a surface somewhat larger than the first named coal-field, may comprise about 60,000 square miles. The Ohio and its tributaries unwater nearly the whole of it, and the main trunk of this great river serpentines through the centre of the region for about 400 miles of the upper part of its course. The Susquehanna and its tributaries intersect the north-eastern extremity of the deposit, and the vallies of denudation in which these waters flow, assisting the effect of a series of nearly equidistant undulations in the stata, there break its continuity into the outliers alluded to, which generally rest on sinclinal mountain tops, in the interrupted prolongation of a number of narrow subsidiary troughs resulting from the undulations in question, and giving an irregular and deeply indented contour to the outcrop of the main body of the coal. The chief part of the outliers, as well as the main body of the deposit, and also the other two great coal-fields described, yield fuel of the bituminous quality; but to the eastward of the Susquehanna, there are three large outliers almost sufficiently important to deserve the designation of another coal-field, in which the fuel contained is of the anthracitic kind.

The undulations which have been mentioned, constitute an important feature in the structure of the country between the St. Lawrence and the Atlantic.* Their ridges or anticlinal axes, preserving a remarkable degree of parallelism, have been traced for vast distances, ranging in a sinuous south-westerly course from Lower Canada to Alabama. Crossing them from north-west to south-east, those farthest from the ocean are broad and gentle, but they in succession become more acute and prominent; and as they do so the dips on the north-west side of the axes increase in inclination in a more rapid ratio than those on the south-east, giving to the undulations the form of waves driven before a gale, until at length the former assume a perpendicular attitude and even present an inversion of the strata.

It is where the flexures reach the Apalachian chain of mountains that the phenomena of these overturn dips are exhibited, and there the undulations, becoming identified with the ridges and vallies of the chain, afford an explanation of the structure of this great range of highlands. The disturbances which have given

* See Professor H. D. Rogers' State Reports on the Geology of Pennsylvania.

origin to these mountains, as they affect the coal measures, must, of course, take their date subsequent to the carboniferous era; but, as may be gathered from what has been said, it is only on the south-east side of the third coal-field that the measures are violently corrugated and fractured. The north-west outcrop exhibits a comparatively quiescent condition, and it would appear from the regular coutour of the Illinois and Michigan deposits, that the disturbing forces had entirely died away before reaching them. It does not seem improbable, however, that the broad low anticlinal arch which separates these two from the other, may have some relation to the expiring effort of those forces, for although its axis cannot be called precisely parelled to the Apalachian undulations, there are yet bends in it that seem to correspond with some of the curves of that chain of mountains. From Monroe County, in Kentucky, this axis takes a gently sinuous course, running under Cincinnati, on the Ohio, to the unper end of Lake Erie: thence it curves to the upper end of Lake Ontario, where my assistant, Mr. Murray, has observed its influence in deflecting the strike of the strata in the neighbourhood of Burlington Bay. It then enters the lake, under the waters of which it probably dies away towards the north shore.

From beneath the three great coal-fields which have been mentioned, the subjacent formations crop out in succession, surrounding their carboniferous nuclii with rudely concentric belts of greater or less breadth, according to the thickness or dip of the deposit, and taking a wider and a wider sweep as they descend in the order of superposition, while they conform at the same time in their superficial distribution to all the sinuosities and irregularities occasioned by geographical and geological undulations. The organic remains of these rocks proclaim them to be contemporaneous with the Silurian and Devonian epochs of Europe, including the old red sandstone; and the Pennsylvanian geologists compute that in their south-eastern development they attain the aggregate thickness of about 30,000 feet. But in the State of New York, where the quiet condition of the northern outcrop affords an admirable opportunity of determining with certainty all the relations of the deposits to one another, not more than one third of that amount can be made out. It would seem, therefore, if the many complicated folds existing on the south-east side have occasioned no error in the estimate, that the formations must thin down greatly towards the north.

These fossiliferous formations, wherever they have been found in actual contact with the rocks beneath, appear to rest upon masses of the primary order. But the geologists of New York consider they have evidence of the existence of a series of non-fossilliferous sedementary strata, in a more or less highly crystalline condition, of an age between the two. As considerable difficulties, however, attend the question, it will be sufficient for the purposes of the present description to unite all the subjacent rocks, whether metamorphic or primary, and to class them under the latter denomination.

The lowest of the fossilliferous strata is a sandstone of variable quality, more purely silicious towards the bottom, and calciferous towards the top, which gives support to a thick and remarkably persistent deposit of limestone, strongly distinguished by its organic remains. This limestone thus becomes an admirable means of tracing out the perimeter of the great western area under consideration. From the north-west border of North Carolina, it sweeps in a broad belt across Virginia to the junction of the Shenandoah and Potomac. Thence traversing Maryland, it passes through Pennsylvania by Harrisburgh, on the Susquehanna, and Belvidere, on the Delaware, accompanied up to this point by the underlying sandstone. Diminished in its thickness, it thence crosses New Jersey, and reaching Poughkeepsie it passes up the valley of the Hudson and Champlain, keeping to the east of the river and the lake, and attains the neighbourhood of Missisquoi Bay. Entering Canada, it proceeds towards Quebec, and it reaches the vicinity of that fortress; but I am not yet aware of the precise spots at which it is visible in its course thither, farther than that I have been informed stratified limestone answering its condition is quarried and burned in the Seigniory of St. Hyacinthe, east of the Yamaska River. As Quebec itself does not stand upon the formation, it probably crosses the St. Lawrence higher up the stream; but it may be seen in the quarries of Beauport and farther down the river, and its limit in that direction is to be found near Cape Tourment, where the underlying primary rocks come to the water's edge. Turning at this point, and following the northern outcrop of the deposit up the valley of the St. Lawrence, it is found to run along the foot of a range of syenitic hills of a gniesoid order, which preserve a very even and direct south-westerly course, and down the flank of which the various tributaries of the great river are successively precipitated in rapids and cascades. On the Maskinongé the syenitic range is about twelve miles in a direct line from the St. Lawrence, on the Achigan about twenty, and it strikes the Rivière du Nord about half a mile south of the village of St. Jerome. Following this stream, the primary rocks, which are close upon its northern bank, gradually assume a course with less of southing in it, until they reach Lachute Mills, when their direction becomes nearly due east. Along this line from Cape Tourment, the basset edge of the limestone does not in all cases come quite up to the primary rock. There is occasionally a space left between the two for the sandstone beneath, and on the Rivière du Nord the calciferous part of this rock, capped by the limestone, is seen in several places in a well defined escarpment about half a mile from the syenitic range, dipping southward at an angle of six degrees, which is probably one or two more than the average inclination along the strike of the northern outcrop thus far traced.

Leaving the Rivière du Nord, at Lachute Mills the edge of the fossilliferous strata, still well defined by the rise of the primary rocks from below them, crosses the township of Chatham, pursuing a direct course to Grenville, on the Ottawa, where the calcareous deposit is seen at the upper end of the canal. A little above the village the primary range comes upon the river, which may correctly be considered the general division between the two until we attain the Township of Hull. A bend in the Ottawa there, cutting deep into the limestone, leaves four to five miles breadth of it on its left bank, and the formation displayed in lofty precipices in the neighbourhood of Bytown, affords the magnificent scenery of the Chaudière Falls. From personal observation I cannot speak of its course farther up the Ottawa, but I understand it reaches the island of Allumet, and thence turning southward, runs through the Townships of Packenham, Ramsay, and Drummond,—crosses the Rideau Canal in Rideau Lake in Elmsley, where, with the subjacent sandstone, it is seen in section at the Upper Narrows resting on the primary rocks and dipping to the north of east at an angle of four degrees,—and sweeping round the adjoining corner of Bastard and Young, traverses Elizabethtown, and reaches the St. Lawrence in the neighbourhood of Brockville. The limestone deposit following the St. Lawrence down to St. Regis, has a wide spread of the sandstone coming from beneath it on the United States side of the river, the lower edge of which passes by Canton, Hopkin, and Malone, These fossiliferous formations, wherever they have been found in actual contact with the rocks beneath, appear to rest upon masses of the primary order. But the geologists of New York consider they have evidence of the existence of a series of non-fossilliferous sedementary strata, in a more or less highly crystalline condition, of an age between the two. As considerable difficulties, however, attend the question, it will be sufficient for the purposes of the present description to unite all the subjacent rocks, whether metamorphic or primary, and to class them under the latter denomination.

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SERIES OF FOSSILLIFEROUS DEPOSITS.

Having thus traced as far as necessary the contour of the lowest deposits of the fossilliferous area under description, and having given the position and superficies of the coal-fields which spread out at the summit of the series, it will be understood that the whole of the space between the perimeter of the latter and the boundary of the former is occupied by the various belts or zones resulting from the outcrop of the successive formations.

The lowest of these fossilliferous sedimentary deposits is the sandstone, which has already been mentioned. It assumes various lithological appearances in different places, and in different parts of its vertical thickness.* At its base it is sometimes a quartz rock, so hard and vitrious as scarcely to be distinguished from the primary masses on which it rests, and it frequently presents the aspect of a conglomerate, as at Gananoqui, with large quartz pebbles in a matrix of fine sand. It is often an even-bedded, even-grained sandstone, yellowish brown and compact, or white, saccharine and friable. It is occasionally of a deep red colour in the lower part; and at Montmorency, near Quebec, Professor Emmons, of the New York survey, states it to be stained in parts by green carborate of copper. The highest portion of the formation sometimes exhibits the character of a breccia, with fragments of a dingy calcareous rock united by an arenaceous cement. But the typical quality of the whole mass, as seen at Potsdam, in New York, where it is extensively quarried for economic purposes, is a yellowish brown sandstone, splitting into rectangular parallelopipeds of almost any required size. It is said to contain few fossils; a bivalve shell (*lingula ovata*) is considered characteristic, and at the top of the deposit fucoids exist. The total thickness of the formation is upwaads of 300 feet.†

This silicious deposit passes into a sandstone of a calciferous quality, which the geogists of Pennsylvania class with the former, but those of New York consider sufficiently marked to be taken as a distinct formation. It is in general a fine grained arenaceous limestone, with some beds of a pure calcareous quality. Towards the lower part it is sometimes drab coloured, yielding occasional beds fit for the purposes of water lime, and a little higher it is geodiferous, the geodes containing calcareous spar, sulphate of strontian, sulphate of barytes and sulphuret of zinc. The fossils of the deposit appear to be characteristic, and they consist of univalve and bivalve shells, corals and fucoids. Its thickness is about 250 feet.

To this succeeds the important calcareous deposit of which the course has been so extensively traced. In Pennsylvania it is taken

* See Professor Emmons' State Reports on the Geology of New York.

† The thicknesses given in this general description are generally taken from localities in the State of New York where the formations approach Canada.

as one formation, but in New York it has been divided into two. The lower part consists of a dark irregular thick bedded limestone, containing frequent and irregular shapes of chert, replacing coralline organic remains. It has a thickness of one hundred and thirty feet, and upon it rests a dark bluish, even-bedded, compact, brittle, pure, limestone, occasionally yielding marble capable of a good polish but liable to fracture in the working. It has some drab coloured beds giving water lime, and at Kingston, which probably stands on it, some of its strata have geodes holding sulphuret of zinc, sulphuret of copper and baryto-sulphate of strontian, a new mineral first obtained by the Honorable William Morris, and analysed by Dr. Thompson of Glasgow, having been sent to him by Dr. Holmes of Montreal, to whose zeal he states the mineralogy of Canada to lie under very considerable obligations. The thickness of this portion of the deposit may be about 140 feet. As well as the previous part, it is considered to possess peculiar fossils, and with it constitutes the New York inferior limestone formation. The superior formation is based in some parts upon a valuable ten feet bed of excellent black marble, extensively worked at Isle Lamotte, on Lake Champlain; above which occur various strata of black limestone, alternating more or less with black bituminous shale, and associated in some places with one or two important bands of a grey colour, and a more crystalline texture. This gray stone is extensively quarried at Montreal, where the Parish Catholic Church and all the best houses are constructed of it. At the top of the general deposit, the bituminous shale predominates over the limestone, and affords a passage to the succeeding formation. To the student of North American geology, no formation deserves closer attention than the one just noticed. It is one of the most persistent of the whole series, both geographically and lithologically considered, and it abounds in peculiar and characteristic fossils, crustacean, molluscan, and coralline. In the New York survey it is called the Trenton limestone, taking its name from the locality of its greatest observed thickness, which is about 400 feet.

The next deposit in the order of superposition is a black bituminous shale, differing very little from the argillaceous part of the previous formation, except that it is said to be a little firmer and to have a double system of natural joints. It disintegrates easily under the general influences of weather, which change its colour to an ash gray. In Upper Canada examples of it may be seen at Wh...

whence it has a run to Nottawasaga Bay; and in the Lower Province at one of the locks of the Lachine Canal, as well as on the Montreal side of the St. Lawrence, from the Lachine rapids to Point St. Charles, where it is occasionally altered by the intrusion of intercalated trap-floors, which of course are foreign to the general character of the deposit. It has distinctive fossils, crustaceans, mollusks and graptolites, and a trilobite, to which the name of *triarthus beckii* has been given, is considered characteristic. The greatest observed thickness of the deposit in the State of New York does not exceed 100 feet.

Upon the preceding lies a deposit of thin gray sandstone strata, alternating with fine easily disintegrating argillaceous shale beds of a greenish colour. This appears to constitute its general lithological character in some localities, but in others variations occur. Some distance from the bottom there is occasionally a band of red argillaceous and purple arenaceous shale, and above it a set of argillaceous strata composed of flattened laminated ovoid pieces, with a glossy black exterior; and the summit of the formation is in certain localities a wide spreading calcareous breccia, made up of angular fragments of limestone and slaty sandstone in a calcareous cement, and occasionally contains so small an amount of arenaceous matter as to yield a good marble, for which purpose it is quarried at Swanton in Vermont, whence its strike is towards Canada. This formation is considered to possess distinctive fossils, but the Pennsylvanian geologists have united it with the argillaceous shales that underlie it. Its thickness may be estimated at 1400 feet.

The next superimposed deposit is a gray, even-bedded sandstone of a rather fine grained, hard and durable quality, used for building purposes, and occasionally for flags and grindstones, with thin interposed layers of a greenish shale similar to that of the previous formation. The deposit is sometimes a silicious conglomerate, and sometimes part of it is a chocolate red sandstone, with shales of the same colour. Occasionally it exhibits white, gray, and reddish limestone strata, or presents the form of a greenish breccia. It has some few fossils, and its thickness is about 100 feet.

The total thickness of the rocks enumerated does not reach 2500 feet, and the summit of the formation last mentioned after running up the south side of the Mohawk valley, quits the State of New York at Oswego. Thence, in a course parallel to the out-crop of the formations above, it reaches Oakville near the head of Lake Ontario, where its position has been determined by my assistant

Mr. Murray, who has also ascertained that from this point it bends round to Collingwood on Nottawasaga Bay in Lake Huron. If a line, therefore, be drawn between these two points on the two lakes, it is probable, taking into consideration the extremely moderate dip and undisturbed condition of the strata, and the general even geographical surface of the country, that no deposit higher in the series than the gray sandstone will be found in any part of Canada between that line and Quebec. There are still to be interposed between the gray sandstone and the true coal measures, a mass of strata equal at the lowest computation to between 4000 and 5000 feet; and we are therefore not warranted reasonably to anticipate the occurrence of any part of those true measures in the district in question. Deceived, however, by the dark colour and mineralogical character of the deposit of bituminous shale overlying the great limestone formation, and unacquainted with true geological inferences, adventurers have not been wanting in Canada ready to expend their money in search of coal by boring in that deposit. Before the appointment of the State survey similar attemps were from time to time made in New York, and in this and other like deposits it has been ascertained that no less a sum than half a million of dollars altogether had been wasted in vain efforts to obtain what a regular geological investigation of the structure of the country, soon demonstrated it would be contrary to all experience to expect in the strata chosen for the search.

Continuing an enumeration of the formations in an ascending order of superposition,* the next in succession to the gray sandstone is a variegated red and green marly and shaly sandstone, of a crumbly nature, with which are associated some bands of quartzose gray sandstone, in some places yielding good flagstones, and in others good building stones. Brine springs issue from the formation, abundant in number, but scarcely strong enough to be converted to profitable use in the manufacture of salt. One of these exists at St. Catherines, in Upper Canada. The fossils of the formation are characteristic. They consist of bivalve and univalve shells and fucoids, and one of these (*fucoides harlanii*) is considered an unfailing guide in tracing the deposit, of which the thickness may be estimated at about 600 feet.

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* See Mr. Hall's State Report on the Geology of New York.

Upon the preceding rests a set of strata, consisting of bright green shales, associated with a partial bed of oolitic fossilliferous iron ore, of which the greatest observed thickness in any place is two feet, and interstratified with two bands of more or less impure limestone containing silicified organic remains. These remains are sometimes replaced by calcedony and agate, and geodes occur containing a number of beautiful silicious minerals, with sulphate of barytes, sulphate and carbonate of lime, and, in small quantities, yellow sulphuret and green carbonate of copper. The fossils are numerous, and consist of trilobites, univalve and bivalve shells, graptolites and fucoids. Among the shells, *pentamerus oblongus* is abundant and characteristic. The thickness of the deposit is variable, and may be taken at eighty feet.

The next formation consists of calcareo-argillaceous shale of a bluish colour, abundantly fossilliferous, on which a few beds of silicio-argillaceous limestone, yielding a good water cement, constitutes a passage into a strong calcareous rock above. The lower part of this consists of a cemented mass of broken encrinital columns, often beautifully variegated with red, to which succeeds a thick-bedded sparry gray limestone, followed by one of a darker colour, upon which rests a brownish bituminous limestone, sparry below, and marked by the presence of the sulphurets of zinc and of lead above, and the whole is crowned by a set of slaty dark gray calcareous beds, with mammillated surfaces, separated by thin laminæ of bituminous shale. It is over a slope and precipice which presents the whole thickness of this limestone, that the rapid and cataract of Niagara falls; and to the assemblage of rocks composing it, and the argillaceous strata below, the geologists of New York have in consequence given the appropriate name of the Niagara Group.

It is said to be in the north-western development of the limestone of this group that the great and valuable lead mines of Wisconsin exist. The group is strongly characterised by its fossils, which are abundant, various, and peculiar, consisting of trilobites, univalve and bivalve shells, encrinites and corals, and its total thickness, where it enters Canada, is not less than 260 feet.

We now come to a deposit which, in consequence of the valuable material it contains useful for agriculture and other purposes, and giving origin to the industrial application of capital, is one of the most important of the whole series. In the lower part it consists of variegated green spotted red shales, surmounted by greenish and drab coloured slaty limestone strata, alternating with red shales, which are followed by brownish calcareous and argillaceous shales, enclosing white and dark coloured masses of gypsum, of which there appear to be two ranges capable of being profitably worked, separated from one another by a band of porous limestone. Hopper-shaped cavities of various magnitudes, supposed to have once contained crystals of salt, exist in the gypsiferous part of the deposit, and the whole is capped by calcareous strata fit for the purposes of hydraulic cement. This formation is the seat of a number of valuable brine springs, and in the County of Onondaga, in the State of New York, no less than 3,134,317 bushels of salt were profitably manufactured from them in 1841. The fossils of the formation are not numerous, and the thickness of the whole deposit, where most largely developed, is about 700 feet.

This deposit, so valuable for its gypsum, salt, and hydraulic lime, occupies a belt of country on the south side of Lake Ontario, running parallel with its shore, and with the subjacent formations, to the variegated red and green sandstone inclusive, passes into Canada across the Niagara river, and occupies nearly all that neck of land which separates Lake Ontario from Lake Erie. This whole assemblage of deposits skirts the shore of the former lake through Niagara County, and attaining the extremity of it, the strike, becoming deflected by the anticlinal axis which has been noticed as existing there, turns northward towards Cabot's Head, on Lake Huron. That promontory is probably formed of an increased development of the Niagara limestone. On the east side of it is the red and green sandstone, to the west will be the gypsiferous and saliferous rocks. These may be seen where they reach the banks of the Grand River, being there already worked for plaster, and it is not unlikely that as they approach the anticlinal arch and gently bend over its back, gradually losing a part of the slight inclination they possess, they will assume a wider spread and occupy a broader zone when they come out upon Lake Huron. Unless the district the formation underlies be deeply buried in alluvium, the mineral contents of the subsoil cannot fail to render it in time one of the most valuable parts of the Province.

In the general classification of the New York system of formations, the gypsiferous rocks are followed by five successive deposits of limestone, each of which is considered to be distinguished by its peculiar fossils. The Pennsylvanian geologists associate all these, and uniting them with the deposits below, the Niagara Group included, make one formation of the whole. The thickness of these five calcareous rocks is not clearly stated by the geologists of New York. They exist in the eastern part of the State, and thin out westwardly before reaching Canada, and it would probably be within the mark to state their average aggregate amount on the south side of Lake Ontario at 200 feet.

To these calcareous rocks succeed three deposits of a silicious character, being sandstones of various qualities, yielding building, flag, and fire stones. They are distinguished by their fossils; the first and last by bivalve and univalve shells, and the intermediate one by a fucoid (*fucoides cauda-galli*) which gives name to the rock. The group is known in the eastern parts only of New York, and, like the limestone immediately below, thins out before attaining the borders of Canada to the west. Though the lowest alone of these deposits is said to be 700 feet thick where known in Pennsylvania, it will probably be sufficient to put the whole down at an average of 100 feet in New York.

Resting on the sandstones in the eastern part of New York, and on the hydraulic limestone of the gypsiferous formation in the west, the next deposit in ascending order is calcareous. It consists of beds of limestone of a light gray colour, occasionally almost altogether composed of broken encrinital columns, having much the appearance of the beds at the base of the Niagara limestone, particularly when, as in it, the organic remains are of a reddish shade. It then yields a handsome variegated marble, and it generally affords good stone for building and for lime-burning. The strata are in many localities separated from one another by thin layers of green shale. Nodules of chert, or hornstone, are common, and towards the top in some places, beds of the silicious mineral alternate with those of limestone, forming a passage into the deposit above. The deposit is considered to possess distinguishing fossils, and I believe it is the lowest in which the remains of fish have been found. The thickness of the mass is twenty feet. In the Pennsylvanian Survey this deposit is united with the sandstones below and the limestone above, one formation being made of the whole. The limestone above is of a compact texture, and varies in colour from drab and light gray, through different shades of blue, to black. The hornstone forming a passage from the lower deposit, is frequently very largely developed in this, and sometimes usurps nearly the whole of the strata. The rock is well marked by its fossils, and its thickness is about seventy feet.

These united bands of limestone quit the State of New York at Black Rock, and strike into Canada at Waterloo, on the Niagara river, whence they run westward along the shore of Lake Erie for some distance. They appear to be recognised again in Ohio and Michigan, at the head of the lake, and they form a belt across the extremity of the southern peninsula of Michigan from Thunder Bay, on the Lake Huron side, to Petite Traverse Bay on the other. It is, in consequence, possible that they may have a wider spread in Canada than their united thickness, not reaching 100 feet, might lead us to expect; and it would seem they are probably the highest rocks whose equivalents underlie the whole of the three great coal-fields in a still unbroken sheet, their outcrops from beneath each becoming confluent in the centre of the great fossilliferous trough that contains them all, around a low, oval, dome-shaped area of inferior rocks, with a nucleus of about 4,000 square miles of the lowest limestone deposit, which is there exposed in the vicinity of Cincinnati. In Canada, however, it is likely that patches of the immediately succeeding deposits may be found in parts of the Western District.

The lowest of these is a black bituminous shale, much resembling the one described as existing further down in the series. It is occasionally sufficiently charged with bitumen to yield a flame when put on fire, and this circumstance, added to its black colour, induced many vain expectations of coal, accompanied by useless and expensive researches for it in the deposit in New York previous tothe institution of the State Survey. The thickness of this deposit is about fifty feet, and it passes into a dark shale of more slaty character, which, by a thin compact calcareous blue shale, is separated from a set of olive coloured fissile shales, gradually passing into a stronger rock by an increase of arenaceous material. This again becomes a bluish grey calcareous shale at the top, and is followed by a thin band of encrinal limestone, to which succeeds a persistent grayish blue marly rock. The whole group of strata abound in septaria. Its fossils are numerous, various, and characteristic, and its thickness, which diminishes from east to west from 1,000 to 300 feet, may be stated at 500 feet. On the top of this group rests a partial bed of limestone, which also thins westwardly. Its greatest thickness on the south side of Lake Ontario is twenty feet, and it dwindles down to nothing approaching Lake Erie, but its fossils are considered characteristic. On the preceeding limestone rests a deposit of deep black consistent fissile shales, of a uniform quality. It has some few fossils sufficiently characteristic, and its thickness, which varies from 150 to 25 feet, thinning westwardly like the immediately subjacent rocks, may be taken at an average of fifty feet.

The next formation in the series, consists of a group of rocks of a more or less arenaceous quality. The lowest of these is a greenish argillo-arenaceous shale, which is followed by a development of green and black arenaceous shales, interstratified with thin beds of sandstone, yielding excellent durable flags, and forming a passage into a mass of thick-bedded sandstone above. Ripple-mark and the casts of shrinkage cracks are common on the surfaces of some of the strata, but the fossils of the group are scarce. Fucoids, indeed, are frequently met with, and one species is found penetrating the beds in a vertical position. Some characteristic shells occur in the lower shales, and others in the centre of the group. The total thickness of the formation is estimated at 1,000 feet.

To this succeeds a mass of gray, greenish gray, and olive flaggy sandstones, interstratified with black, olive and green argillaceous and arenaceous shales, accompanied by frequent beds so charged with organic remains as to acquire the quality of an impure limestone. Towards the top the sandstone occasionally presents the character of a conglomerate. The fossils are numerous and plants are among them. The plants are sometimes covered with a coating of crystallized coal, and many of the surfaces of the beds are so powdered with carbonized comminuted vegetable remains as to give to the strata very much the semblance of coal measures. Even practical miners might be deceived by the appearances; but no workable coal seams are found associated with the deposit, while its organic contents, agreeing with its stratigraphical position, point out that its age is anterior to the true carboniferous era. The thickness of the formation is estimated at 1500 feet.

The out-crops of these two important formations of sandstone, and of the group of shales below entirely surround the three great nuclii of coal, with the exception of the north-western extremity of the Illinois deposit, where the whole thin away together before completing the circle. The flatness of the general trough, and the great thickness of the sandstones, cause them to assume a very wide and conspicuous figure.

The next superimposed formation where it is fully developed consists of sandstones, argillaceous and arenaceous shales, impure arenaceous limestones and conglomerates. The sandstones are sometimes fit for grindstones, and the general colour of the deposit is red, or some shade of red. In the eastern part of New York among the Catskill mountains, the thickness of the formation is said to be little under 2500 feet, but it thins down to the westward, and on the south of Lake Erie in Pennsylvania, it dies away altogether. Its ascertained organic remains are not numerous, but among them are some of the fishes appertaining to the old red sandstone of Europe, one of which is the *holoptychus nobilissimus.*

This rock is not known to crop out from beneath the coal-fields of Michigan and Illinois, nor from beneath any part of the north-western side of the third great carboniferous area. Its basset edge, however, constitutes a belt on the Atlantic side of this last coal-field from New York, through Pennsylvania, Maryland and Virginia. But in Virginia there is interposed between it and a persistent conglomerate which is at the base of the workable coal-seams, a narrow band of limestone, contemporaneous with the carboniferous or mountain limestone of Europe. This is scarcely recognized in Pennsylvania, and not at all in New York; but it bounds the south-eastern rim of the coal measures in Tennessee and Kentucky. Under the coal-field of Illinois it becomes an important formation, constituting a broad ring completely round it, as it does a narrow one round that of Michigan. In Michigan, however, the conglomerate mentioned as elsewhere supporting the workable coal, does not exist; but it bounds the south-eastern half of the Illinois coal-field, and entirely encircles the great coal area to the east, its greatest development being on the south-eastern side in Pennsylvania.

In New York this conglomerate rests upon the red sandstone formation, and it is a strong and solid arenaceous rock, loaded with quartz pebbles. It has a few fossils and towards the top, alternates in Pennsylvania with the workable coal-seams, and gradually passes into the general mass of coal measures above. Such is the general character of the various deposits which fill up the great trough under examination.

INFERIOR ROCKS.

Without determining whether the non fossilliferous rocks upon which the organic series rests, be sedimentary at the summit and primary below, or whether they belong to the latter class only, the general figure they present on the map may be inferred from the fossilliferous contour already described. In so far as Canada is concerned they constitute the whole of the northern parts of the Province, stretching from one extremity to the other. They compose the north shores of the St. Lawrence and the Ottawa, with the exception of the narrow strip of fossilliferous deposits between Cape Tourment and Grenville. They form the northern and eastern shores of Lake Superior, and the northern coast of Lake Huron; and from between Matchadash Bay in the latter, and Allumet Island on the Ottawa, they run into a south-eastern spur which terminates in a huge mountainous peninsular mass, lying between Lake Champlain and Lake Ontario, and joined to the main primary body by the narrow Isthmus of the Thousand Islands.

These rocks consist of talcose and other slates, quartz-rock, gneiss, limestone, serpentine, granite, syenite and their subordinate masses. The limestones and serpentines yield marbles of various beautiful descriptions; the feldspathic rocks in their decomposition afford good porcelain clays; copper ores are found in several localities; veins of lead ore have been worked; plumbago is abundantly developed; chromate of iron is known to exist, and the whole system appears to be associated with large and valuable supplies of the magnetic and specular oxides of the same metal.

The extraordinary abundance in which these two latter ores of iron are found, may render them of great importance in an economic point of view. In the Champlain district of the State of New York, they give employment to a considerable amount of capital, engaged in smelting operations, and the iron produced from them by means of charcoal is of a quality to compete with the best descriptions manufactured in Sweden and Russia. Professor Emmons, in his final Report on the Geology of New York, mentions the existence in that part of his district, bordering on Lake Champlain and the St. Lawrence, of upwards of seventy veins and beds of these ores, varying in thickness from two and five feet up to 160 feet, and of two in particular, of which one is 514 feet and the other 700 feet thick; and while it is impossible to put a sure limit to the depth to which these enormous masses may extend, their course on the surface has been traced to considerable distances. The 514 feet bed has been followed for two and a half miles, and the overwhelming amount of metal in it may be conceived when it is stated that in a mile every five feet in depth would yield about one million tons of pure iron. This bed is not yet brought into operation, but some estimate may be formed of a value, from the fact that four veins called the Arnold veins, which have an average aggregate thickness of about twenty-two feet, and are mined some of them at a depth of 260 feet, a distance of only one quarter of a mile, are leased at a rental of 6000 dollars per annum. Such extraordinary masses of iron ore, one would suppose, cannot fail to become of national importance, and when we consider that valuable deposits of the same mineral quality are already known in Canada, in the townships of Marmora, Madoc, Bedford, Bastard, Hull and other places, and reflect upon the great extent of the primary regions in so many parts of which the magnet is deflected from its meridian, most probably by the proximity of the magnetic oxide, it is not unreasonable to hope that a diligent search may disclose provincial beds of equal consequence.

It is at the summit of the rocks under description, in the peninsula lying between Lake Superior and Lake Michigan, in a great range of trap interposed between the transition series and a metamorphic group, which rests upon the granite, that Mr. Douglas Houghton, the State geologist of Michigan, has made the discovery of an important collection of copper ore veins, which are likely to become of considerable economic value, and it yet remains to be ascertained whether an analogous condition of circumstances may not extend to Canada.

TERTIARY AND ALLUVIAL DEPOSITS.

Over many parts of the great area which has been described, whether primary or transition, there is spread a more recent sedimentary deposit, which is still in a soft condition and consists of various beds of clay, sand and gravel. These beds are characterized up to heights of 500 feet above the level of the ocean, by the frequent presence of marine shells, of the same species as now inhabit the Gulph of St. Lawrence and the northern seas. Fifteen species have been found at Portneuf, near Quebec, at the height of 300 feet, and five of the same on the mountain of Montreal at about 460 feet above salt water level, while in various parts of the St. Lawrence and Champlain vallies, such remains are seen at more moderate elevations. The geographical distribution of these deposits, which are denominated tertiary of the post-pliocene or most recent age, has not yet been fully described, but the materials of economic value they possess are clays fit for the manufacture of common bricks and common earthenware, with sand for building and moulding.

Still more recent than the tertiary deposits is the alluvial drift, with which are associated boulders of igneous and other rocks, occasionally fit for mill-stones, with frequent extensive deposits of peat and fresh water shell marl, both well known to intelligent agriculturists to be of very great importance as manures, when properly applied; and bog iron ore often met with in tracts sufficiently large and rich to give profitable employment to capital in the manufacture of iron of the best quality.

I have thus given a general sketch of the main features of the physical structure of the area with which the geology of that part of the Province west of Quebec is connected, chiefly as ascertained by the various surveys of the neighbouring States. That in the materials which fill up the great sedimentary trough, and those which compose the rocks on which it rests, many modifications, both as to quality and amount may be found to exist in their Canadian development, can readily be believed. But these changes and the exact limits to the distribution of each formation, with the localities of such portions of their contents as have economic value, can be determined only by the patient and laborious examination of several years.

The progress made during the past season in the Geological Survey of the western division of the Province, will be indicated by the accompanying Report I have the honor to place before Your Excellency, from my assistant, Mr. Alexander Murray, who was instructed to examine the country, lying in a general line between Georgian Bay in Lake Huron and the lower extremity of Lake Erie.

LITHOGRAPHIC STONE.

In Mr. Murray's Report, Your Excellency will observe mention made of the discovery of one or two extensively developed limestone beds, supposed to be fit for the purposes of lithography, at Rama on Lake Simcoe. The geological position of these beds is at the bottom of the deposit of limestone described as occupying a place near the base of the great fossilliferous trough, which in Rama rests upon the primary rocks, without the interposition of the sandstone generally beneath it: and Mr. Murray's attention was drawn to a search for the material by the fact that stone of a similar description had been found in a precisely equivalent position in the Township of Marmora, a circumstance which now renders it probable that the beds may have a continued run between the two points distant from one another seventy miles. On a visit to Marmora in September 1842, made for the purpose of ascertaining the limits of the fossilliferous rocks, I obtained a specimen of the stone from Mr. Wm. Fidler, of Rawdon, and having taken it with me to Britain, it was placed in the hands of one of the principal lithographers of the Metropolis, whose Report on it after trial, is as follows:—

77 CORNHILL,
17*th May*, 1843.

SIR,

I beg to inform you that my experiments with the Canadian stone, No. 547, which you left with me to be tested, were eminently successful. I forward you herewith some impressions from drawings made on that stone, proving its applicability to the purposes of lithography.

I think this discovery an important one, the more so, as I have had stones brought to me from various parts of the world to test, and none of them heretofore have proved satisfactory.

I shall be most happy to render you any assistance in my power in bringing these stones before the public.

The specimen of stone No. 210, is not applicable to lithography. It is too brittle and does not retain the drawings. I send some specimens of impressions from it.

I remain Sir,
Yours faithfully,
(*Signed*,) WM. STANDIDGE.

W. E. LOGAN, ESQ.

The unsuccessful stone was from a bed running under the city of Kingston, a few rough trials of which, made in the country, had induced some to consider it worthy of more skilful experiment. The other is the Marmora specimen, and the Rama stone is so exactly like it in almost every respect that the one can scarcely be distinguished from the other, and its applicability to the same purposes appears to me highly probable, though, of course, it will be prudent to submit specimens of it also to the ordeal of a practical test, before asserting it positively. The great probable extent of these beds and the facility with which a large supply of the material may be obtained at Rama, are circumstances which would make the discovery of unquestionable importance to the arts. For the purpose of ascertaining what its value may be to the Province, inquiry has been instituted, but I am not yet in possession of the details necessary to authorize the expression of an opinion.

Lithography is an art of comparatively recent date. It is not eleven years since Senefelder, the inventor of it, died, and scarcely more than forty have elapsed since it was first introduced into Britain. But during the last twenty years it has been so sedulously cultivated, that it is now a branch of trade of nearly equal importance with copper-plate engraving. In Germany, Belgium and France, even more is done in it than in Britain, and at the present time there is scarcely a town of the smallest importance, whether in Europe or North America, in the East or West Indies, in which it is not practised to a considerable extent. Improvements in it are at intervals discovered, and its applications are yearly extending. It is used in calico printing, and recently it is said to have been successfully tried in multiplying the results obtained by the Daguerreotype. Stone fit for the purposes of lithography, has thus become an article of commerce, researches have been made for it in many countries, and the French Government some years since offered a premium for the discovery of it within the limits of the French territory. But though stones have been there found near Chateauroux (Department de l'Indre) partially fit for the purpose, the defects in them are so great that it is difficult to obtain perfect specimens of larger dimensions than twelve inches square. In England some of the beds of the white lias met with at Corston near Bath, have been tried, but they are only fit for inferior purposes, and the only really good stones hitherto known are those first resorted to on the discovery of the art. They are obtained in considerable abundance in the quarries of Solenhofen, on the Danube in Bavaria, and from them the whole world is at present supplied.

The value of these in the British metropolis, properly prepared is twopence farthing a pound, and in New York they bring from five to seven cents. After a careful selection, by the rejection of such specimens as have soft spots or hard crystals, the preparation necessary to render the stones fit for sale, consists in giving them a face ground perfectly smooth and flat, and a back and sides roughly tooled, care being taken to keep the face and back perfectly parallel. The sizes best calculated to find purchasers in the English market, none of the stones being under three inches thick, are as follows, the figures in the last column being intended to indicate the proportions in which the sizes should be assorted.

6 by 9 inches.	
8 " 12 "	3.
10 " 12 "	
11 " 15 "	
12 " 18 "	
12 " 20 "	
13 " 16 "	2.
13 " 17 "	
15 " 19 "	
17 " 21 "	
18 " 24 "	
22 " 30 "	1.
24 " 32 "	
26 " 36 "	
32 " 48 "	
36 " 36 "	

The last two sizes, of which only a few would be required, are intended for calico printing.

EASTERN DIVISION.

The relations of the rock masses which compose that part of Canada lying to the eastward of Quebec and Lake Champlain and south of the St. Lawrence, constitute a much more complicated question than the western section presents; and I am not aware that enough has yet been done in the countries bordering on it to furnish facts sufficient to establish a precise order of superposition, or to follow out the formations in their geographical distribution. The State of Vermont has not yet been examined, nor has that of New Hampshire, and though a survey of Maine was some years ago commenced, I believe it has not been completed. The labours of Dr. Gesner in Nova Scotia and New Brunswick have done much to bring before the world some of the main features of the Lower Provinces; but there is still much wanting, particularly in that part of New Brunswick lying to the north, to afford an exact elucidation of the subject, or to enable such inferences to be drawn as would materially assist the investigation of Eastern Canada. It would thus be impossible for me to give a general sketch of the geological area, of which it constitutes a portion, that would be free from great liability to error, before a much larger amount of information has been collected ; and even if the dearth of facts were less, circumstances exist connected with the peculiar conditions of the area in question, which would render it necessary that much caution should be exercised in combining those ascertained. It is these conditions which distinguish the eastern from the western part of the Province, and they consist in the violent contortions of the strata, the altered nature of some of the rocks, and the want of conformability in probably more than one member of the series of formations.

In very general terms, indeed, the area to which Eastern Canada appertains may be described as a sedimentary trough, resting upon primary rocks, with a transverse axis, reaching from Labrador in a south-east direction to the Atlantic coast of Nova Scotia, and a longitudinal one extending probably from the centre of Newfoundland to some uncertain point in the New England States of the American Union. The centre of it is occupied by a great coalfield, covering nearly the whole of New Brunswick, and a considerable part of Nova Scotia, Cape Breton Island and the south-western corner of Newfoundland, while there is a large portion of it lost beneath the gulph of St. Lawrence. It would be premature to assert or deny that rocks of more recent secondary age rest upon this, but the lower part of it appears to hold important deposits of gypsum. The carboniferous rocks are affected by disturbances on the south side of the trough in Nova Scotia, giving origin to undulations which are subordinate to its longitudinal axis; while they appear to have suffered less from such disturbances, either in the centre or on the north, where the coal measures from Shediac to Miscou have very moderate angles of inclination. Both on the south and on the north the coal formation seems to rest unconformably on the rocks below, and in these the flexures produced prior to the deposit of that formation, are so violent,that in many places the strata come against its base nearly at right angles: from which it results that the coal measures rest sometimes upon the basset edges of the highest subjacent sedimentary deposits, and sometimes upon the granite, and the carboniferous perimeter is no guide whatever to the geographical range of anything coming from beneath.

The boundary of these lower formations in Canada, is the north bank of the St. Lawrence, from Labrador to Cape Tourment, near

Quebec; but what their succession may be, and how far they agree in fossil, lithological, or economical results with the superposition of the New York series, can only be determined after careful examination.

To gain information on these points, and particularly to ascertain the north limit of the coal deposit, have been the object of my labours during the past season. With a view the better to prepare myself for the investigation, it appeared to me expedient, on my arrival at Halifax from Great Britain on the 31st May, that I should journey by land across Nova Scotia and New Brunswick to Canada, and in so doing take the opportunity of visiting the celebrated display of coal measures at the Joggins on the Bay of Fundy, with the hope that it might prove serviceable to me in studying the more northern parts of the deposit. The accompanying section of the strata there exposed, reduced to vertical thickness, will exhibit the results of my inspection. After viewing in a cursory manner, the neighbourhood of Dorchester, Richibuctoo and Miramichi, and other places on the route, on reaching Bathurst a short time was bestowed on the examination of about fifty miles of the coast, on the south side of the Bay Chaleur, from Jacket River to Pokeshaw; and I then entered upon operations in Canada, devoting myself to a very minute and detailed investigation of the coast between Cape Rosier and Paspebiac, including short distances up some of the main streams. To illustrate this section sixty large boxes of mineral and fossil specimens were collected and sent round to Montreal by water.

During the winter I have had an opportunity of comparing some of the fossils with those of the New York rocks, in the State collection at Albany, and I have to express my obligations to Mr. Hall and Professor Emmons of the New York Geological Survey, for the readiness with which they facilitated my investigation.

Not having yet been able to complete an arrangement of the facts ascertained in the Gaspé section, it appears to me preferable that I should reserve an exposition of them until a succeeding Report, when the labours of another season in the same part of the Province will probably have enabled me to combine a wider range of circumstances, and render the subject more intelligible. I shall, therefore, on the present occasion, only farther add that the materials observed having economic value, were silicious and calcareous sandstones fit for building and flagging, and some probably capable of being used for grindstones; silicious conglomerates, probably fit for mill-stones; limestone; lead and iron ores, perhaps not workable; and fresh water shell marl.

SUCCESSION OF DEPOSITS.

The succession of rocks developed in the section in an ascending order of superposition, is as follows:

1. Thin bedded grey limestones, with a few thicker occasional layers of conglomerate limestone, made up of grey limestone pebbles in a calcareous matrix; succeeded by grey and black shales, (sometimes the one and sometimes the other colour predominating) with thin beds of grey limestone; on which rests a series of red, purple and black shales, having a few beds of black bituminous limestone, and interstratified with hard light grey sandstones, sometimes large grained and almost a fine conglomerate; terminated by black shales with thin beds of limestone, some of which at the top are arenaceous. The total thickness of these deposits is considerable, but uncertain. They are not well displayed, being much covered by sand and shingle on a low coast. They are also much contorted, and it is not determined whether they are conformable with the deposits that follow them in the series.

2. Gray limestones with corals, encrinites, shells, and trilobites; succeeded by greenish or olive coloured shales with occasional red bands; on which again rest gray limestones; to which succeeds a considerable thickness of greenish shales; surmounted by a great mass of limestone shale and good limestone. The thickness of the whole formation, which is well loaded with fossils, is from 1500 to 1800 feet.

3. Gray, greenish gray or drab-coloured, and red sandstones, of a free grit, with many layers of red, and occasionally gray shales. The sandstones are often charged with various descriptions of silicious pebbles, and blood-red jasper occurs among them in considerable quantity, sometimes accompanied by fortification agate. The pebbles are frequently so numerous as to constitute a conglomerate. When the sandstone beds are thin and flaggy, their surfaces are often covered with carbonized comminuted plants. In some of the sandstones and some of the shales, argillaceous iron ore occurs. The total thickness of the formation, which has some fossils, is about 4000 feet.

4. Conglomerate beds, of which the matrix is red sandsto and the contained pebbles consist of limestone of various coloı chiefly gray, with quartz and and other silicious materials, incl ing blood-red jasper. With these conglomerate beds are associa red sandstones and some red shales. The thickness of the forr tion is uncertain, and it lies unconformably on those below. It probably an inferior member of the carboniferous series, but it see to be too low down to contain any of the profitable beds of coal.

I have the honour to be,

Your Excellency's most obedient servant,

(*Signed,*)

W. E. LOGAN,

Provincial Geologist.

REPORT

OF

ALEXANDER MURRAY, ESQ., ASSISTANT PROVINCIAL GEOLOGIST,

ADDRESSED TO

W. E. LOGAN, ESQ., PROVINCIAL GEOLOGIST.

WOODSTOCK, *March 14th*, 1844.

SIR,

Agreeably to the instructions received from you, previous to my departure from Britain, I proceeded, on my arrival in this country in the month of May last, with only so much delay as was required to procure maps and other necessary documents from the Government Offices in Kingston, to make a geological examination of the district lying in a general line between Georgian Bay on Lake Huron, and the lower extremity of Lake Erie; and I have now to submit to you the following Report of my progress in the investigation.

As Toronto occupies a position in the appointed line of section, my operations were commenced there, and while in that neighbourhood I examined the country between the Rivers Credit and Don. Subsequently I proceeded to Lake Simcoe, the whole circuit of whose shores was narrowly explored; and ascending all its rivers and creeks, I lost no opportunity of obtaining such information as would tend to a knowledge of the general character of the country. From Lake Simcoe I descended the River Severn to Lake Huron, and examined the coast there from Coldwater River, round Matchadash Bay, as far as Penetanguishine. After which, crossing over land to the Narrows on Lake Simcoe, and proceeding to Barrie, I struck to the westward, for the purpose of visiting certain lime-stone rocks which had been described to me as existing in Nottawasaga. Having determined their position, I followed their course through the townships of Mulmer, Melancthon, Amaranth, Mono, and part of Albion, and returned to Toronto.

Having, by a careful comparison of the characteristic fossils, and an observed striking similarity in lithological appearance, satisfied myself that the blue shales which occupy the country around Toronto, were to be identified with the Lorraine shales of the New York geologists, I next visited the townships of Scarborough, Pickering and Whitby, with a view to ascertain the junction of these blue shales with the subjacent black bitumimous shales, which I had information were to be seen near Windsor village in Whitby.

My next expedition was from Oakville, on the shore of Lake Ontario. Crossing the river Credit, I traced it up through the townships of Toronto, Chinguacousy, and Esquesing, and returnec through Nassagaweya, Nelson and Trafalgar. My object on thi occasion was to ascertain the strike and boundary of the group o rocks which repose on the Toronto blue shales. This group con sists of red and green shales, and fine grained sandstones, witl coarse red sandstones, and green spotted red marls, and the lowes out-crop they exhibit is on the Lake shore at Oakville. I wa likewise anxious to determine the character of the limestone rang of hills so extensively displayed through the townships of Nelsor Nassagaweya, Esquesing and Chinguacousy; having had reason t suspect that the rocks of Nottawasaga and those of the ridg between Hamilton and Queenston, would prove to be of the sam formation, and that an anticlinal axis would be found to exist som where between Ancaster and Dundas; a fact which I conceive have now gathered sufficient evidence to establish.

At a subsequent period I examined in succession the various fo mations which strike through the country, included between tl Grand River as high as Paris, and Lake Ontario as far as t Niagara River to the east.

With a view to obtain a correct profile for a general line of trai verse section, I commenced a series of barometrical measuremen which it was my intention to have extended to each place I shou visit, but having ascertained the heights of some of the most cons cuous points, my instrument was by an unfortunate accid broken; and through the impossibility of getting it properly repair

I was under the necessity of abandoning the design. I shall, however, be able to remedy the deficiency resulting from the circumstance, by availing myself of the surface elevations of a section presented to the Provincial Legislature, by the late Mr. Thos. Roy, Civil Engineer, who, it appears, had bestowed much time and attention on the subject of geology, and is said to have levelled the line of country over which his section runs.

With such a transverse section, to shew the attitude of the strata, as they dip beneath one another, and a vertical one to represent the thickness of each and all the formations that compose the country, from the primary rocks on the banks of the Severn, to the upper limestones on the shore of Lake Erie, accompanied by a map of the surface, reduced to one scale from the charts of different districts, at present in my possession, and coloured by various tints, to represent the geographical distribution of the deposits, I shall at a future time be able satisfactorily to represent the physical structure of the area, which has engaged my attention.

A collection of the fossils and minerals peculiar to each formation were forwarded in the autumn to Montreal, for your inspection. It is not so extensive as I should have desired, but the difficulties attendant upon inland transport, often from the midst of the forest, and the limited assistance I had it in my powei to obtain, rendered its extension impossible.

In investigating each group of strata, I have usually endeavoured to determine its equivalent in the State Geological Survey of New York, referring to the classification of rocks established by that survey, as a standard by which a vast amount of labour and time might be saved in Canada. This has been done with the less hesitation, as, while it is well known that the undisturbed condition of the south side of Lake Ontario has afforded a true natural order of superposition, many of the rocks of that State strike immediately and visibly into the Province, along the line of border. And although there may exist occasional disparity in the thickness and consequent superficial spread of some of the rocks common to both countries, their mineral, as well as fossil conditions, in general, place the relation they bear to each other beyond a doubt. I have, therefore, in the following list of the Canadian rocks, which have come under my inspection, attached to each formation the name of what appears to me its equivalent in the American classification, with the view of rendering the subject the more easily understood.

In the district which has come under my examination, the ar-
ngement of superposition, in an ascending order, stands thus :—

Canada Rocks.	*New York Denomination.*
1. Primary or metamorphic rocks	
2. Gray, buff or blue limestones	Trenton limestone, including the Black River & Chazy limestones
3. Black bituminous shales,......	Utica slates.
4. Bluish shales and sandstones,..	Hudson River group.
5. Red and green sandstones, shales and marls, including a remarkable band of white sandstone at the top,.........	Medina sandstone.
6. Limestone and green shales,...	Clinton group.
7. Black and dark coloured slates and shales,............. 8. Bitumimous and magnesium limestones,....................	Niagara group.
9. Red shales,.................. 0. Gypseous shales and hy-draulic limestone,...........	Onondaga salt group.
1. Upper limestone,..............	Corniferous limestone.

To annex to each of the sedimentary deposits its appropriate ickness with a certitude of accuracy, is a matter next to impossi-le ; for, in consequence of the near approach to horizontality, which ne strata almost everywhere present, it is very difficult, with a hance of success, to estimate what the dip may be. The breadth herefore, which any formation exhibits can scarcely be made vailable in a calculation ; and it is only when an accidental section s laid bare, as in the case of the Hamilton Ridge, that the truth can e satisfactorily arrived at. But assuming the rate of inclination, he strata possess to be no more than thirty feet in a mile, the fol-owing would be an aproximation to the vertical amount :—

No. 2 —	540	feet.	
" 3 —	510	"	
" 4 —	1110	"	
" 5 —	614	"	
" 6 —	24	"	
" 7 —	63	"	
" 8 —	120	"	
" 9 — " 10 —	300	"	
" 11 —	60	"	at Fort Erie.
	3341	Feet.	

1. PRIMARY AND METAMORPHIC ROCKS.

These rocks comprise the whole of the country to the north of Lake Simcoe, and the north-eastern shores of Lake Huron ; and their character, in the localities visited by me, may be described as exactly similar in appearance to that of the masses which compose the "Thousand Islands," in the Saint Lawrence below Kingston. The boundary between them and the lowest beds of the stratified limestone is distinctly seen at the head of a small sheet of water called St. John's Lake, in the township of Rama, within the distance of a mile from Lake Couchiching, and it is easily traceable from the one lake to the other. The River Severn, which unites the waters of Lake Simcoe with those of Huron, passes its whole length over the primary rocks : and their junction with the fossilliferous sedimentary deposits may again be observed on the south shore of Matchadash Bay, and at the mouth of the Coldwater River. The line of junction, therefore, may be considered to run in a direction about W. N. W and E. S. E., the whole of the Township of Matchadash and the northern half of Orillia being on the primary.

Considering that my object, in the first instance, should be to determine the boundaries of the several formations as they might occur, with a view to entering into more minute details at a future period, I did not penetrate into the primary region in search of metals or minerals. The general character of the region, however, is such as would justify a careful and vigilant search for them when the general geology of the country is better known. Among these rocks I obtained some specimens of noble garnet ; and a rich one of sulphuret of antimony, picked up among the drift on the shores of Lake Simcoe, was, in all probability, originally derived from them. Strong local attraction of the magnet, is said to have been observed in several places in the township of Matchadash, by Mr. Hamilton, the gentleman who made its survey, and it is probable that iron ore of the magnetic kind exists in it.

The rock masses observed in the primary district partake severally of the characters of granite, syenite and gneiss, and on the banks of the Severn, at a spot between the Fourth Falls, and Fifth or Great Falls, they seem to me to present evidences of stratification. The strata there rise vertically from the edge of the stream to the height of fifty to sixty feet, and have all the appearance of coarse micaceous sandstone, which is in some places much contorted and frequently intersected by quartz veins. This exhibition of divisional planes, having all the regularity of bedding, induces me to consider that the term metamorphic, is one of appropriate application to some of the rocks beneath the fossilliferous, and unconformable with them.

In an agricultural point of view, the primary region on the banks of the Severn must be considered nearly valueless. With the exception of the accumulation of vegetable matter in the hollows where swamps exist, the country presents a surface of naked rocks, the only production of which is a dwarf pine. There is some good soft timber, however, in the swamps, and were the land capable of being drained, the swamps might be reclaimed and converted into meadows. But they are in general so nearly on a level with the river, that drainage would be impossible.

2. STRATIFIED LIMESTONE.

As already mentioned, the boundary of this limestone is distinctly discernible in the township of Rama, between Lakes St. John and Couchiching, and there is little doubt that it may be traced from the fifth lot of the 9th concession of Orillia, on the shore of the latter named lake, to the south bank of Coldwater river in Matchadash Bay, and thence to the western horn of Hog Bay. This is the last point westerly, at which the strata are visible, the whole of the Peninsula of Penetanguishine, further on in that direction, being enveloped in drift. The present wants of Penetanguishine are abundantly supplied from large loose masses of limestone, which with boulders of granite are strewed on three distinct terraces or broad tables of land, from each of which there is an upward step to its successor, visible on both sides of the bay, marking very clearly three separate epochs of recession in the great lake. The limestone beds of the western promontory of Hog Bay, and all its projecting points, are probably identical with those of Rama. They are abundantly fossilliferous. The mineral condition of the fossils is remarkable, being frequently coated with a thin crust of a green colour, probably carbonate of copper. Among the detached pieces of limestone on the beach, are fragments of a drab colour and close texture, possessing the appearance of a stone suitable for the purposes of lithography. But I could not perceive any bed in situ corresponding with them. Such a one, however, may exist below the level of the water. At the mouth of Coldwater river, the lowest members of the deposit are green coloured, fine grained sandstone, in beds of eight to twelve inches in thickness, interstratified with green argillaceous shales. The sandstone is in great request among the Indians, for the purpose of manufacturing tobacco pipes. It is soft and porous when first taken from its bed, but becomes hard and compact after exposure some time to the air. The Indians carve out their pipes with a common knife, to which the stone yields easily, and it is not improbable that vessels of larger capacity and greater utility, such as troughs suitable for various purposes on a farm, might be made with equal facility. These lower beds in total thickness do not exceed eight to ten feet, and they appear to be destitute of fossils.

In consequence of the strata being very nearly horizontal, it is extremely difficult to determine their dip, either as to direction or inclination. That of the Matchadash beds appears to be south, while that of the more western strata seems to point south-west. The inclination in both cases does not probably exceed thirty to thirty two feet in a mile.

The following are accurately measured sections of the lower limestones at different places in the township of Rama, taken in ascending order :—

At St. John's Lake, South of the Junction.

		Ft.	In.
1.	Gray compact limestone with crystals of calcareous spar, ...	0	8
2.	Gray compact limestone with fewer crystals, ...	1	4
3.	Gray compact limestone, with fossils coated with a thin crust of a green colour, ...	0	7
4.	Lighter coloured, very close grained limestone, with an uneven fracture, probably fit for the purposes of lithography, ...	0	10
5.	Brownish tinged limestone slightly arenaceous, with an uneven fracture,	1	3
6.	Gray compact limestone, with crystals of calcareous spar, ...	1	8
7.	Gray coarse grained limestone, splitting into thin laminæ, ...	1	3
8.	Dark gray compact limestone, ...	0	10
9.	Dark gray slaty calcareous shale, ...	0	4
10.	Dark coloured very hard and compact limestone, ...	0	10
11.	Dark coloured very hard compact limestone, tinged with oxide of iron,	0	1
12.	Bluish coloured limestone very hard and compact, ...	0	4
13.	Gray coarse grained limestone, slightly arenaceous and unevenly deposited, ...	1	10
14.	Reddish tinged hard and compact limestone, ...	0	11
15.	Reddish tinged hard and compact limestone, ...	2	0
16.	Dark coloured limestone with more fsssils than are possessed by the lower beds, ...	4	0
	Total thickness above the surface of the Lake	18	9

Quarry on the Shore of Lake Couchiching.

	Ft.	In
1. Strata over the lake line hid with broken fragments, ...	3	
2. Gray close compact limestone, ...	1	
3. Dark grey shale, ...	0	
4. Dark brownish coloured limestone, ...	1	
5. Dark brownish coloured limestone, ...	0	
6. Drab coloured close compact limestone with a smooth, concoidal fracture. This would probable be found a good lithographic stone, ...	0	
7. Drab coloured limestone, similar in texture but not quite so fine as No. 6, ...	0	
8. Drab coloured limestone, similar in texture to No. 6, but not quite so fine, ...	1	
9. Drab coloured limestone, similar in texture to No. 6, but not quite so fine, ...	1	
10. Drab coloured limestone, similar to No. 6, but perhaps containing more crystals. If it can be procured sufficiently free from crystals of calcareous spar, it would probably yield an excellent material for lithographic purposes, ...	0	
11. Blue compact clear grained limestone, ...	1	
12. Blue limestone, ...	1	
13. Bluish gray compact limestone, ...	1	
14. Gray sparry limestone slightly arenaceous, ...	1	
15. Gray sparry limestone, ...	1	1
Total thickness above the water of the Lake	17	

From the circumstance of the strata lying perfectly flat, th quarrying of these rocks is attended with little difficulty. The afford the best of material for burning, and some of the beds give beautiful stone for building. For these uses a large quantity annually shipped off to different parts of Lake Simcoe, and an inex haustible supply can easily be obtained between the Junction an the Indian village.

Should the two bands mentioned in the foregoing sections, as pr bably fit for lithographic uses, be found perfectly so in reality, aft careful experiment, the quarries of the neighbourhood would becom extensively important, and might be turned to great account. A unlimited supply might apparently be got out on the lake shor whence it could be shipped to the Holland Landing, and thenc transported to the city of Toronto, a distance less than thirty mile

In the Rama limestone organic remains are not numerous, and frequently appears that the interior of a shell-form, and sometimes th whole of the fossil, are replaced by calcareous spar. As in the cas of the Hog Bay fossils, a green crust occasionally envelopes the ex terior, and it is a peculiarity of the rock that stripes of the same colour are common, especially where they are developed on the shore of Lake St. John. The Gaol and Court House at Barrie, are examples of the applicability of the Rama stone for the purpose of building.

To the south of the Point immediately north of the Indian Village the strata become covered up by drift, but the whole of the neighbouring country is strewed with large fragments of the same qualities of limestone as previously described. On the western shore of Lake Couchiching, as on the western shore of Lake Simcoe, there is no single instance of an exposed section. Neither the banks of streams, nor the margins of ponds or small lakes, display anything below the alluvium, which must occasionally be of great thickness; for in many places the land composed of it rises to a very considerable elevation; and I would instance the district between the Narrows and Matchadash Bay as exhibiting the greatest accumulation.

Proceeding southward from the Narrows, the strata, after an interval of concealment, are again exposed in many parts of the Township of Mara. They are seen on the banks of the Talbot River, but the sections there are seldom over five feet in thickness, and a better display exists at the northern extremity of Canise Island, opposite the mouth of the Talbot, where the beds present an aggregate of ten feet over the waters' edge. The upper layers are thin, coarse, and irregularly deposited, but the lower ones are thicker and afford good limestone for burning. This locality is very fossilliferous and the remains are frequently replaced by crystalized carbonate of lime.

On Graves Island, which is to the south of Canise, are to be seen some calcareous rocks, which constitute the development of probably the very highest part of the whole deposit. Thence south-eastwardly, they strike the main shore on the property of Captain Turner, lot No. 22, of the first concession of the township of Thorah, not far from the lake corner of the Township of Brock: and as I am informed the same limestone is again to be met with on the 23d lot of the 8th concession of the last mentioned township, on the property of Mr. Henry Edward, it is probable that a line through these various points will correctly represent its general direction of strike, which would thus be as nearly as possible N. W. and S. E.

On Captain Turner's lot the beds are from three to eight inches thick, and constitute an aggregate of ten to twelve feet over the surface of Lake Simcoe. They yield excellent lime when burnt, and are occasionally fit for building and flag stones. At this place a favourable opportunity is afforded to determine the dip. It would appear to be westerly, and as the strata seen on the lake shore crop out about half a mile from it eastwardly, where they stand at an elevation of about thirty feet over the lake level, the difference between these figures and the height of the strata at the margin of the water would give a rise of something more than fifteen feet for the distance, which, as in the other instance would be about thirty feet per mile.

Another evidence of the direction of the dip may be found in the soundings of the lake. The waters of the eastern shore are shallow, with a hard and solid bottom of limestone, while those of south-western parts are deep, having a bottom of mud, or covered with large boulders. Kempenfelt Bay holds deep water in every part, and at the mouth of Cooke's Bay, Snake and Markego Islands are instances of great accumulations of large boulders, mixed with sand and gravel, standing on deeply buried strata. I conceive this to be shewn by a reef running from the latter island, and composed of large rounded rocks of granite, which, when the lake is low, have not more than a few inches of water over them, whilst on either side the depth increases rapidly down towards the solid strata, which give support to the culminating mass of detritus.

The country immediately encircling the whole of Lake Simcoe, is covered with large boulders of the primary rocks, intermingled with great fragments of the stratified limestone. But they are especially prevalent on its western shores. From the Eight Mile Point near the entrance of the Narrows, all the way to Kempenfelt Bay, enormous granite blocks strew the shore; but the detached masses of limestone are not so abundant. Where these do occur they are seldom water worn, but appear in the form of great slabs with angular edges and flat surfaces, as if removed only a short distance from the parent bed, and the fossils they contain seem to be the same as those of Rama, while the mineral character of the fragments is identically so. The largest primary boulder observed, might weigh about 100 tons, bnt in many places the number of more moderate dimensions is so great as to prevent the possibility of tilling the land.

From the 27th lot of the 6th concession of Oro, on the lake shore, up Kempenfelt Bay, as far as Col. O'Brien's residence, on the 1st lot of the 2d range, east of the Penetanguishine road, the marginal land is low and sandy, giving support to a growth chiefly of cedar and hemlock trees: but at the latter place it rises to a considerable height, and consists of clay. The step thus formed stretches off in a northerly direction, leaving the extensive flats already described as covered with boulders, between it and the lake, and there cannot be much doubt that at some former period it constituted the limit of the water. But as the remainder of Kempenfelt Bay is bounded by this bold slope all around, it is probable that it was a bay, as now, when the surface of the lake stood at a higher level and covered a greater area.

The existence of shell marls in several parts of the low grounds, seems to be a corroborative proof that the waters covered many parts now dry. These are found generally in low swampy situations and immediately beneath the vegetable mould. A bed of it occupies a position near the east point of Cooke's Bay, on the property of Mr. Haynes, who discovering it while digging a drain, imagined he had struck upon a bed of gypsum. Where he had cut through it the thickness did not exceed six or seven inches, and from the general aspect of the locality, it appears to me the extent is probably not very considerable. It is made up of comminuted shells, among which are *planorbis* and other fresh water genera; and in its appearance and consistency it resembles whitening, for which the proprietor had used it as a substitute. Such deposits being nearly pure carbonate of lime, it is well known may be used with great advantage in agriculture.

The southern shores of Lake Simcoe are extensive sandy plains, which are in many places thickly strewed with boulders, and bear proof of having once been the bottom of the lake. Wherever gravel is found its pebbles consist of limestone, and with the larger fragments of that formation they contain the fossils of the calcareous strata which have been described; but the sand is silicious and slightly ferruginous. That at Holland Landing is almost altogether made up of small grains of quartz; but the colour it presents in mass is nevertheless indicative of the presence of iron.

The mouth of Holland River at the head of Cooke's Bay, passes through a great marsh, which is bounded by the sandy plains in question, and as in this marsh and in almost all low and swampy ground in the District, bog iron ore appears to occur in more or less quantity, it may be a question whether the sources of the ore are not to be found in the sand. The Black River falling into the lake at Jackson's Point in the township of Georgina, takes its name from the colour of its waters, and the dark tinge of these, tenaciously maintained by the stream until it has proceeded a far way into the lake, may possibly be derived from passing over some deposit of the mineral. Capt. Bouchier, R. N., and his brother, who reside near the banks of the Black River, and from whom I received much kindness and assistance, informed me that wherever an excavation is made in the neighbourhood of their mill, and around the adjacent springs, great quantities of iron pyrites are observed. They pointed out to me spots where they had at different times made collections of it; but only a few particles were then distinguishable, shining among the mud. The decomposition of pyrites would be another source for the derivation of the bog ore.

The timber produced in the swamps containing the bog ore, is chiefly black ash and frequently cedar, and the luxurious growth generally observable in these places, may probably be due to the presence of sulphate of iron, derived from the decomposition of the pyrites, which would facilitate the nutrition of plants, by acting in the mode of sulphate of lime.

3. BLACK BITUMINOUS SHALES.

The only locality in which I have hitherto seen this rock is in the Township of Whitby. The outcrop of some of the strata belonging to it are exposed on the banks of the creek at Nash's brewery, in the village of Windsor; and at Bowerman's mills on the 32d lot in the third concession, a well has been sunk in the formation, to a depth exceeding fifty feet. A specimen was presented to me by Mr. Ross, the Surveyor of Barrie, which he had obtained from the 2d concession of the Township of Collingwood, north of the Blue Mountains on the shores of Lake Huron, and as this in fossil and mineral character is identical with the specimens from the Windsor beds, we have reasonable evidence to conclude that the formation is constant from the one great lake to the other, and that its junction with the limestone below is in some position not far removed from the calcareous strata seen in Graves Island, and in the Township of Thorah.

The upper limit of the formation I have no where seen, and it may be possible that no section exhibiting it is any where exposed. But the superior blue shales are displayed on the banks of the

River Rouge, near the dividing line between the Townships of Markham and Pickering: so that the junction of the two deposits on the shore of Lake Ontario, must occur at some spot between that river and Big Bay, at the head of which the village of Windsor stands.

This rock in its bed is a shale of a jet black colour; it is hard and brittle and splits into thin laminæ, which enclose between their surfaces a delicate pellicle of bituminous appearance. Becoming dry after removal from its bed, if the shale be again wetted it soon cracks and falls to pieces, and when exposed to the action of the weather it rapidly decomposes, and at length forms a dark coloured clay which constitutes a good soil. The fossils described by the American geologists, as characteristic of the Utica slates of New York, are in great abundance in the rock. I obtained specimens of the trilobite *triarthus beckii*, with the conchological genera *avicula* and *orthoceras* in Whitby, and the shale from Collingwood contained similar organic remains.

The mineral character and black appearance of this deposit has frequently led to the belief that it must be associated with coal, and the rock has frequently been itself represented to me as actual coal, which has been worked and burnt. When a piece of the shale is thrown upon the glowing embers of a fire, assisted by the thin coating of bituminous matter between the laminæ, it will flame brightly for a few moments, and after a short exposure to a red heat, it will leave as a residurum a white or gray slaty ash, about as bulky as the original shale. This property has occasionally fixed the opinions of those predisposed by the colour of the rock to pronounce it to be coal. They do not consider that to cause the shale to flame requires more wood than the bulk of the material on which they try their experiments; that the flame will cease the moment the wood is removed; that the combustible material in the shale is so small that it leaves a residuum diminished only in an imperceptible degree; and they are not aware it has been ascertained that at the summit of the whole series of deposits of which this shale is a very inferior member, true crystalline workable coal exists with all its fossil as well as mineral characteristics, and that it would therefore, be contrary to experience to find it lower down.

Iron pyrites sometimes coats the fossils of the formation, and it abounds in all those parts of it which I have examined. To the decomposition of this pyrites, is probably to be attributed the mineralized waters found in the district underlaid by the deposit. A well which was sunk at the brewery on the creek at Windsor, in search of fresh water for a distillery, yielded a supply so strongly sulphureous, that, altogether unfit for the object intended, some thoughts were entertained of turning it to account as a mineral spring for medicinal purposes. Another well, sunk on the rock at Windsor, near the Lake Shore, by Mr. Cording, on a piece of land on which he had built a new and commodious house, intended for a tavern, yielded a similar result. At the time of my visit Mr. Cording was engaged in blasting the rock, an operation which must have been attended with considerable expense, for the hardness of the shale renders it in the first place sufficiently difficult to drill, and the explosion acting on its brittle nature bursts it into shivers, making it tedious and troublesome to clear the work as it proceeds; and he seemed disposed to abandon the task when he was informed that in all probability the deeper he went the worse the water would be. I may here remark, as a fact worthy of observation, that I have not yet in any one instance, found the water of which I could trace the source to the older stratified rocks of this country, in the whole area which has come under my examination, to be of a good, fresh, drinkable quality, while that of the tertiary or alluvial deposits is of the best kind and most agreeable to the taste, although I have found it all more or less charged with carbonate of lime.

Near Bowerman's Mills, already mentioned, in the 32d Lot of the 3d Concession of Whitby, there is, on the west branch of Lynd's Creek, a well, which has been sunk to the depth of seventy feet. It penetrates—

	Feet.
Gravel accumulated by the brook, ...	5
Clay containing rounded pebbles, chiefly of limestone, ...	15
Black bituminous shale, ...	50
	70

The water it yields is strongly saline, and salt has been manufactured from it, but it was of inferior quality, having a bitter taste and a dark colour, occasioned by some foreign ingredients, which the manufacturer did not know how to get rid of. The work was in consequence abandoned, and the well allowed to fill up. I procured a sample of the water, however, from the depth of fifty feet from the surface, or twenty feet from the bottom, and forwarded it to Montreal for analysis, but I believe it was subsequently lost through the effect of the frost, which burst the vessel containing it.

The Township of Whitby appears to be as fine an agricultural district as there is in the Province. It is said to be well adapted for wheat, and the soil consists chiefly of clay, occasionally topped by a thin covering of sand or gravel, the pebbles of which are chiefly limestone. In the neighbourhood of Windsor, the country rises gradually from the lake, and forms two distinct terraces, the one being 160 feet and the other 320 feet over the level of Ontario. These gradually approach each other going westward, and run into one in the Township of Scarborough, near Gates' Tavern, on the Kingston and Toronto road. On the upper terrace the land is light, and in every way inferior to the soil on the lower one. The heights at Scarborough are composed of clay, sand, and gravel, and the following is their elevation above the level of the sea :—

	Feet.
First terrace above the Lake, ...	161
Second terrace above the first, ...	159
Second terrace above the Lake, ...	320
Surface of Ontario above the sea, ...	234
	554

4. BLUE SHALES AND SANDSTONES.

These rocks compose the sub-strata of the whole country on the shore of Lake Ontario, between the River Rouge, in the Township of Pickering, on the east, and the River Credit, in Toronto, on the west, and sections of them may be seen in almost all the streams that intervene between the one point and the other. The estimate I have made of their thickness brings it to 1,110 feet. How near this may approach the truth it is difficult to say, but the result of such evidences as I have had it in my power to collect being still in favor of supposing the dip to be at about the rate of thirty feet to a mile, it is probable that the figures given constitute a tolerable approximation.

The formation consists of a series of bluish coloured argillaceous shales, enclosing bands of calcareous sandstone, sometimes approaching to limestone, irregularly deposited and of variable thickness. In some instances the bands are of a slaty structure, splitting into thin laminæ in the direction of the beds; in others they have a solid thickness of a foot; but in few cases do they maintain either character for any great distance. The sandstones, while in the bed, are hard, solid, and compact, and upon fracture exhibit a gray colour, with much the appearance of limestone; but exposure to the weather turns them to a dark brown, and under the influence of the atmosphere they crumble and decay. They in general abound in organic remains. Hence it results that they are calcareous, deriving the lime from the shells they have entombed, and when the fossils are more than usually abundant, the bed may occasionally become a limestone. Limestone beds, however, are not common. Were such a stratum found extensively developed in any place in the neighbourhood of Toronto, it would be of great value, as there is a considerable consumption of lime in the city, the stone yielding which is at present transported from some distance. The slaty variety of the sandstones is well adapted for flagging, and for this purpose it has been a good deal used in the streets of Toronto. By a careful selection these arenaceous beds may yield abundance of good building material; but it requires such care, as the stone cannot be said to be in general adapted for the purpose.

The banks of the Credit, the Etobicoke, the Minaco, the Humber, and the Don, for certain distances from the Lake Shore, expose sections exhibiting sixty feet or more of these rocks; but advancing to the northward, as the land increases in elevation, the formation becomes concealed by the great accumulation of tertiary and alluvial deposit, of which the interior of the country is composed. At Weston, on the Humber, between the Townships of Etobicoke and York, some good limestone occurs; and at Fisher's Mill, below Dundas Street, on the same river, there is more of the same material. At the latter place the banks of the stream rise to a height of more than 100 feet, of which from fifty to sixty feet are composed of these blue shales and sandstones, while the upper part consists chiefly of sand and gravel.

Many of the settlers, in the country underlaid by this formation, seem to be strongly impressed with the opinion that it contains coal. In some instances I found them unwilling to listen to any reasons which might interfere with their prepossession; and while a few, possessed of indications satisfactory to themselves, carefully conceal from general knowledge all information of the localities of their supposed buried treasure, through an apprehension, as I was informed, that the Government would claim a right to all minerals discovered, others have proceeded more boldly to work, and have bored to a considerable depth in search of the material. At Weston, on the Humber, I found that a company of adventurers had been partially formed, boring rods provided, an old miner employed, who, I believe, was a speculator in the concern, and the rock penetrated to a depth of 150 feet. Having, when two thirds of the distance down, passed through a band of shale of a darker colour than usual, it was pronounced to be coal, and the work was continued in confident expectation of a larger seam, until a deficiency of funds, more than a want of hope, caused the suspension of operations. Mr. Tewer, the person employed to put down the hole, very kindly supplied me with the following account of the strata penetrated, which are given in the descending order :—

	Feet.	*Inches.*
Exposed in the bank—		
Clay, ...	6	0
Blue shale, ...	12	0
Gray hard calcareous sandstone, ...	4	0
Blue shale, ...	6	0
Blueish limestone, ...	1	0
Blue shale, ...	11	0
Penetrated by the borer—		
Limestone, ...	1	0
Hard calcareous sandstone, ...	3	0
Dark-coloured shale, ...	6	0
Alternate thin layers of slaty arenaceous limestone and dark coloured shale, ...	40	0
Dark coloured sandstone, ...	1	2
Limestone, ...	1	4
Limestone of impure quality, ...	2	1
Limestone, ...	1	8
Dark shale, ...	0	10
Black shale, (*mistaken for coal,*)	0	2
Dark coloured shale, ...	0	10
Ironstone, (*this is improbable,*)	0	8
Alternations of hard impure limestone and shales, ...	28	0
Ironstone, (*this is very improbable,*)	1	0
Alternating layers of limestone and shale, ...	14	4
Total, ...	142	1

At the depth of sixty feet below the level of the river, Mr. Tewer describes the borings to have been highly impregnated with saline material, and to have emitted a strong sulphureous odor. It is not improbable that the bands described as ironstone were loaded with pyrites, the decomposition of which would give rise to the odor referred to; but the source of the salt is a more difficult question.

Brine springs occur in several localities among these shales, but I am not aware of their having been converted to any profitable purpose. Mr. Jones, an Indian resident at the Indian Village on the Credit, informed me, that about thirty miles up the river, in the Township of Chinguacousy, there is a strong brine spring, and that salt had been made from it, but he was unable to state the proportion of salt in the water, or whether any other constituent was present with it.

The organic contents of the blue shales are very numerous. The most characteristic are a species of *pterinea*, a *cypricardia*, an *orthis*, a *strophomena*, and a large *othoceras*, each of which is figured by Professor Emmons in his final report on the geology of the second district of the New York Survey, as peculiar to the Hudson River group, or Loraine shales.

In the section of country covering this formation calcareous tufa is of frequent occurrence among the beds of tertiary deposit. In the Township of York, on the banks of a small tributary of the River Don, crossing Yonge Street near Wilmsley's Pottery, within a few miles of Toronto, it is quarried, burnt, and used as lime. Impressions of the leaves of beech and other trees, and vegetables, are abundant in it, and the banks of the stream, to the height of twelve to fifteen feet, are entirely composed of this calcareous deposit, which is again overlaid by clay and sand.

The clays of the same spot are employed in the manufacture of coarse pottery, for which they seem to answer a good purpose, and the sand which overlies them has been used for glazing the ware. They are likewise well adapted for brick making, and they have been extensively devoted to this use.

5. VARIEGATED RED AND GREEN SANDSTONES AND MARLS.

Farther examination of this group of rocks may perhaps lead to a more minute division than is here given them; but for the present, as they have been but partially explored, as the colour and mineral character of the whole are essentially similar, and as there is a great scarcity of fossils in them, none, as far as I have seen, being well defined, I have deemed it sufficient to class the whole under one description.

Admitting the rate of dip to be still the same as already assumed, the probable average thickness of the formation will be about 614 feet, and it constitutes the whole of the shore of the upper extremity of Lake Ontario, from the River Credit round by Hamilton, to the River Niagara. Its junction with the subjacent shales is at Oakville, on the lake shore, and the lower part of the series of rocks of which it is composed may be seen there, and again three miles below Norwell on the Credit, in the centre of the 12th lot of the 11th concession, in the Township of Esquesing. It consists of red and green coloured slaty sandstones and marls, and the colours are so arranged as to give the rock a striped appearance. A few obscure fucoids are the only fossils I have hitherto seen near the base of the formation, and at its summit even these are remarkably scarce or altogether wanting, as I have yet met with none so high up. At Wellington Square one of its members crops out in a thick, red, coarse-grained sandstone, which yields to the influence of the weather on exposure, and therefore is inferior for the purposes of building. The remainder of the series, up to the gray band at its summit, is made up of red indurated marls, with green spots and stripes, interstratified with irregular thin bands of red sandstone. The best development of the series occurs on the Niagara River, where there is an exposed thickness exceeding 200 feet. From the Niagara River to Hamilton, sections of it may be seen in almost every brook which has worn a channel from the Ridge to the lake, and on the north side of Burlington Bay it is equally well developed for many miles.

Throughout this series of rocks brine springs abound, and in several places salt of good quality has been extensively manufactured from them. But the competition resulting from the brine springs of the County of Onondaga in the State of New York, which have their origin in a higher formation, and are of superior strength to any yet found in the red sandstones and marls, has hitherto prevented the Canadian manufacturers from working to a profit, as they found themselves undersold in the market by the American article, which was imported into the Province in considerable quantity, before the duty was taken off Liverpool and other seaborne salts.

At St. Catharines, on the Welland Canal, Dr. Chase, to whom I am indebted for much kindness and consideration, established a salt manufactory some years since on a very extensive scale, and at great trouble and expense. But the profits were insufficient to remunerate him, and he was obliged to abandon the works, part of which is now converted into a distillery, and the only use to which the brine is at present applied is to supply water for hot and cold baths to a small establishment erected hard by for these conveniences. Dr. Chase informed me he had bored no less than 507 feet below the surface, equal to 484 feet beneath the level of Lake Ontario, through red marls and sandstones all the way, and that a tube had been introduced into the bore hole to the depth of 396 feet. When the water was allowed to accumulate it yielded, after pumping off the first 40 feet, from 6 to 10 per cent. of salt; but the lowest portions would hold even as much as from 24 to 25 per cent. But, the first supply exhausted, the strength of the brine gradually diminished, until the pumping was suspended and an accumulation of the water again permitted. The reason of this variation in strength appears obvious. While the accumulation was going on the supply of saline particles brought to the bottom of the tube would, by their superior specific gravity, remain in the lower part of the bore hole to the displacement of whatever fresh water might come in at the same time; whereas the uninterrupted drain of the pump, when this accumulation was exhausted, would bring up a mixture precisely proportionate in strength to the quantities of salt and of fresh water simultaneously poured in from the strata.

There appears to have been much difference of opinion as to the depth which ought to be penetrated to obtain the strongest and best supply of brine, and the prevailing impression seems to be that the greater the depth the more abundant will be the salt. It is very true that saline particles may be more or less disseminated not only down through this series of strata, but even down through all the sedimentary deposits to the lowest beds of stratified limestones which approach the primary rocks, as is indicated by the saline springs at Kingston and elsewhere, and therefore it might be inferred that the greater the amount of strata penetrated the greater would be the amount of the salt entering the bore hole. But the probability is that the saline particles which supply the brine are more abundant in, or perhaps wholly confined to, certain strata at considerable vertical intervals from one another, and it would therefore altogether depend on this interval whether a depth of 100 feet would not give as much salt as one of 510 feet. Then again, it must be recollected that every stratum of rock in the whole thickness pierced will give a certain quantity of water, whether salt or not, and that some of them may yield a very large supply of fresh water. It may therefore happen when two vertically distant sets of salt bearing strata are penetrated by the same bore hole, that though the quantity of salt supplied to it will be greater, the brine coming from it will be more diluted than if only the upper saliferous bed had been cut. It will be seen from this too that if the same salt bed be penetrated by two different bore holes, one to the dip of the other, and therefore going through a greater number of strata, the chance is the deeper bore hole will give the weaker brine, unless great care be taken to exclude from the pipe the supply of water, coming from the upper layers; and the same would be the case if the slope which caused the accumulation of strata was an upward one on the surface instead of a downward one in the bed. Another circumstance to be taken into consideration is that the greater number of strata penetrated the greater the chance of meeting with some ingredient prejudicial to the taste of the salt. It is no doubt the result of some circumstances such as these that, at Mr. Kent's works near Stoney Creek, the strongest brine was obtained at 136 feet from the surface. The whole depth there penetrated is 400 feet from the surface, or 394 feet below the level of Lake Ontario, and it required 150 gallons of brine to make an average of 56 lbs. of salt. At Dr. Chase's works the same quantity of salt was produced from 130 gallons.

Salt is still manufactured in the Township of Saltfleet, and, I believe at Wellington Square, and brine springs are of common occurrence in the Townships of Nelson and Trafalgar. Should these rocks at some future period be found to yield the same material farther north, among the wild tracts of Huron, as it is very reasonable to suppose they do, they may become of great importance to that fine country as it becomes settled.

Sulphureous springs are common, particularly in the higher parts of this series. On the 1st lot of the 6th Concession of Barton, there is a spring which evolves carburetted or sulphuretted hydrogen, from which, being capable of combustion, it has been termed *The Burning Spring*. Its waters have been used medicinally for several disorders, and since its discovery it has been resorted to by many invalids who are said to have derived great benefit from its use.

Near Beamsville there is a remarkable spring, which is reported to be frozen over during the summer months but never during the winter. I visited it on the 11th September, when the weather was warm and sultry, and can bear testimony that it was frozen over then, although the temperature of the atmosphere was 80° of

Farenheit within the distance of 3 yards from its issue. It is concealed and protected from the solar rays by great masses of rock that have fallen down at the place. I have not yet seen it in winter, but can credit the report given of it, as similar springs have been described by Mr. Murchison as existing in Russia, in some red gypsiferous rocks of that country; but no satisfactory solution has yet been given of the phenomenon.

The uppermost member of this series of rocks, very appropriately denominated the "gray band" by the American Geologists, is remarkable for its persistency, both in extent and lithological character, and it forms an admirable means by which to trace the strike of the formation through the western part of the Province, from the Niagara River to Nottawasaga on Lake Huron. It varies in thickness, in so far as I have hitherto observed, from eight to eighteen feet. It is generally a fine grained white silicious sandstone, but at other times it is extremely hard and compact, and somewhat calcareous. In the former case it makes a beautiful building stone; in the latter it answers well for a few purposes, but it is then in general too hard and brittle, and having a bluish tinge, is very inferior in point of appearance. The stone now using in the construction of the new College of Toronto is quarried from this bed, and affords a beautiful example of its best condition.

On the Welland Canal, near Thorold, the gray band is hard, compact, and silicious, but it is very irregularly deposited. From this circumstance its value as a building stone is there much deteriorated, though it nevertheless answers well for the purpose when it can be procured of sufficient thickness.

I have observed the rock, or certain indications of its presence, in most places along the Ridge from St. Catherines to Hamilton, in the Township of Hamborough West, in Nelson, Nassagaweya, and Esquesing.

In Esquesing it assumes a more conspicuous character than I have elsewhere seen. Coming from below the superincumbent limestones its outcrop extends beyond them for a considerable distance eastward, and it can with ease be quarried in many places on the surface of the ground. On the 17th lot of the 5th concession of the Township it is a white fine grained thick bedded stone, with ferruginous specks, and with thin partings of red marl in the divisions of the lowest strata. It is there 18 feet thick, and constitutes a very handsome stone for building purposes. On the 6th concession it might be quarried to a considerable extent with great facility, being covered for a great distance with nothing more than vegetable mould, which is of no great thickness. From this I have traced it to Mono and Nottawasaga, and from information received from several persons who were well acquainted with the Townships of Collingwood and St. Vincent, I am prepared to believe that it extends through them, and that it constitutes the lowest of the hard rocks which form the Blue Mountains.

In some of the Northern Townships some of its strata have been used for grindstones, for which purpose they are occasionally very well adapted.

It will be observed in the course which the gray band presents through the western part of Canada, that the formations which enter the Province at the Niagara River have an east and west strike until they attain the upper extremity of Lake Ontario, and that thence they sweep round in a general direction nearly due north. This fact, of course, must be the result of an anticlinal axis, which meets the strata at the point of deflection, and it naturally constitutes an important feature in the physical structure of the country.

6. GREEN SHALES AND GRAY LIMESTONES.

At the spot where I have carried my section across these rocks they are unimportant in thickness, and it will require further investigation to decide whether they are worthy of being classed by themselves, or whether they should be included under one general head with the shales and limestones by which they are overlaid. They are, however, rich in organic remains, many of which appear peculiar to them, and at Hamilton, to the westward, there seems to be evidence for supposing that they assume more importance, there being at that place a thickness of 136 feet between the gray band below and a set of black shales above. A comparison between a vertical section there and one at Thorold would stand thus :—

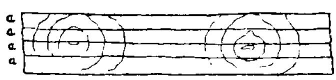
THOROLD.	Ft.	In.
Clay, ...		
Encrinal limestone,.............	7	0
Geodiferous and bituminous limestone,............	26	0
Limestone,.........................	8	0
Water limestone,................	8	0
Black shales,.......................	55	0
Hamilton limestones,........	10	0
	10	0
Shales with fucoids,............	4	0
Gray band,..........................	10	0
Red sandstones and marls to the level of Lake Ontario,............................	224	0

ANCASTER.	Ft.	In.
Geodiferous and bituminous limestones,......................	5	0
	3	0
	3	0
	3	0
	3	0
	3	0
	5	0
	5	0
	6	0
Black shales,......................	60	0
Hamilton limestones and shales,.........	13	0 filled with chert
	3	6
	5	7
	1	0
	35	0
	7	0
	4	3
Pentamerus band: the bed is completely filled with the shells,......................	5	0
	1	6
	2	6
Shales,..............................	this part is hid 18	0
	19	0
	3	6
	9	0
Gray band,...........................	12	0
Red marls and shales to the level of Lake Ontario,....	250	0

The green shales reposing on the gray band abound in a fossil which, up to the present time, I have not observed in any other position. It is a marine plant or fucoid, which consists of a number of articulated branches starting in groups from various furcations of an articulated stem, and bent and twisted into many shapes and forms.* Some beautiful examples of this fossil were procured at the cutting on the Welland Canal, near Thorold, and in the same bed near Beamsville, further west. A bed containing much iron pyrites is associated with the green shales.

Upon these rest a set of impure limestone beds, which are separated by thin partings of blue shale. They occupy a thickness of ten feet, hold an admixture of argillaceous material, present a compact appearance, and are of a bluish colour. A peculiarity observable in the rock is the frequent occurrence of concentric rings of discoloration formed round a small cavity on the surface of the joints cutting the stratification at right angles. The circles generally cross the divisional lines of several of the beds, as exhibited in the following diagram, in which *a a a a* represent the beds:—

Fig. 1.



Characteristic of this limestone there is a large bivalve shell, which I have not yet noticed either below or above the rock; it is a *pentamerus*, and strongly resembles the *pentamerus oblongus* of Murchison.

Over these beds another limestone occurs very different in its mineral appearance, and, in so far as I have observed, in its organic contents. The large bivalve shell peculiar to the rock below altogether disappears, and we have instead encrinites and multitudes of small shells, among which a species of *atrypa* is common. The colour of the rock is gray, it is coarse-grained and crystalline, and has particles of iron and copper pyrites disseminated through it. At Thorold the upper part of the beds is not exposed, but it is probable that they are not more than ten feet in thickness.

Without further investigation it is impossible for me to say with certainty whether these are the sole representatives of the Ridge

* This plant is the *fucoides harlanii* of the New York geologists, but is given by them as belonging to the Medina sandstone.

limestone seen at Hamilton, or whether the rocks immediately above might be classed as belonging to them; but the natural inference from a comparison of the sections is, that the black shales which are in the limestone just described, are a continuation of the black shales which crop out near Ancaster, and which may be seen in several places between Ancaster and the Forty-mile Creek, overlying the cherty beds constituting the upper tier of the Hamilton rocks. Were it otherwise it would be necessary to suppose a thinning of the black shales at each of those places in contrary directions, a phenomenon which is quite possible. A reference to the vertical section given will explain this.

In the green shales of this series, fossilliferous iron ore may be looked for. It is known to exist in them with some degree of inconstancy in New York, and fragments are to be found in many places along the Hamilton Ridge: but the solid strata here are generally concealed by a quantity of detrital matter, derived from the shales which enclose the ore. I have met with ferruginous fragments from the boundary line between the Townships of Barton and Saltfleet, all the way to the Township of Nottawasaga, but I have seldom seen it in place. In a brook near the boundary line of Barton and Saltfleet, there are two bands of red sandstone, occupying a position among the shales, which may in this case represent the bands of iron ore, and in a brook which crosses the macadamized road near Ancaster, there is an out-crop which is fossilliferous, argillaceous, of a red colour and generally similar to the argillaceous ore described by Mr. Hall, of the New York Survey. Whether it is sufficiently rich to be worth working should a sufficient supply be attainable, will require an analysis to prove satisfactorily.

7. BLACK SHALES.

This rock succeeds the last series of deposits in the ascending order, and is well developed in many places along the Ridge near St. Catharines, where intersected by creeks and rivers; and at the Falls of Niagara, where a thickness of nearly forty feet is seen. Where the line of section crosses, I have estimated the total thickness to be sixty-three feet, which must be very near the truth, as that measurement agrees with the elevations levelled by the Engineers of the Welland Canal, who cut through the whole formation in the construction of the locks. The information derived from them has enabled me to make the comparison, and I have to express my thanks to Mr. Barrett and Mr. Power, the chief Engineers, and to the other gentlemen connected with the works of the Canal, for their kindness in rendering me every assistance in their power, while I was employed in their neighbourhood.

These black shales possess a bituminous character, which with their colour has (as in the case of the shales lower down) frequently led to the unfounded belief that they must be associated with coal. Occasional beds of limestone, loaded with fossils, are enclosed in the shales, and the upper stratum being frequently a limestone fit for the purposes of an hydraulic cement, is therefore of importance and value. It is quarried largely at Thorold, and employed in the construction of the locks of the Canal. In some places, as in the Beaver Dam Creek near St. Catharines, thin bands of half crystallized gypsum occur, occasioning a riband-like appearance in the shales, and in others, as at the Falls of Niagara, snowy gypsum is met with in small nodules, with iron pyrites and other extraneous substances. These shales contain numerous fossils, and a small long-tailed trilobite is among the most common.

A reference to the comparative sections given above, will shew the relative position and thickness of these rocks at the east and west ends of the Hamilton Ridge. I have not seen them in place on the north side of the anticlinal axis, though I do not doubt of their existence there; but it will require further investigation before we can determine how far they may extend. In the Townships of Nottawasaga and Esquesing, fragments of black shale (there as elsewhere erroneously taken as a certain indication of coal) are frequently turned up by the plough. In all probability they are derived from a continuation of these rocks. None of the specimens which came under my notice contained fossils, but in their mineral character and appearance they were very similar to the strata at Ancaster.

8. BITUMINOUS AND MAGNESIAN LIMESTONES.

These rocks form the upper part of the ridge which extends between the Falls of Niagara and the village of Ancaster, and where the section line crosses their out-crop, I have estimated them to possess the same thickness they present at the Falls, where seventy feet of geodiferous limestone stands between the top of the water-lime and the edge of the precipice, and fifty feet of bituminous quality extending from the edge up the river, are run over by the rapid above the cascade. The following section exhibits the exact measurement as taken near the Clifton House, on the ferry road:—

	Ft.	In.
Dark gray bituminous limestone, ...	50	0
Gray limestone containing geodes of snowy gypsum, sulphate of strontian, blende and galena, ...	10	6
Gray limestone, the geodes fewer but larger, ...	6	0
Blue limestone of a more compact character, ...	4	6
Gray compact sparry limestone, in one massive bed, with occasional large geodes, ...	13	0
Dark blue limestone, in beds varying from 2 to 4 inches, with indistinct remains of encrinites, ...	4	0
Gray compact bands of limestone, with a peculiar serrated junction, generally covered with a thin pellicle of bituminous matter, ...	10	6
Blue or grayish limestone, made up of broken encrinital columns, ...	8	0
Strata hid by detritus, ...	13	6
	120	0

At Thorold, on the water-lime, there is a thickness of forty feet of limestone, which is overlaid by geodiferous rocks. In the openings at Hutt's quarry, where the stone is obtained for the works on the Welland Canal, the lowest bed of it is a dark blue bituminous limestone, which makes a good building stone. A quarry of this blue stone is worked on Mr. Keefer's property, near the village. Gypsum occurs in it in small lumps, and a coating of bitumiuons matter covers the fossils and the surfaces of the beds. Upon this blue stone rest twenty-six feet of encrinal limestone, in massive beds of from six to ten feet thick. It makes the very best material for construction, and is altogether employed for the facing of the locks on the Welland Canal. This is quarried out at Mr. Hutt's, a small distance to the eastward of Thorold. Over this encrinal limestone there is a bed of seven feet thick, which, as a building material, is inferior to the former, although of good quality. Both the last mentioned rocks contain numerous fossils, and occasionally geodes filled with snowy gypsum occur in them, particularly in the seven feet bed. Crystals of galena are sometimes met with. At Ancaster the same rocks are not more than thirty-five or forty feet thick.

The whole range of these limestones is highly bituminous, and it abounds in fine cabinet specimens of selenite, sulphate of strontian, pearl-spar, and other varieties of the carbonate of lime, with blende and galena.

Crystals of galena exist in a greater or less quantity in all the limestones from those next above the gray band to the summit of the bitumino-calcareous rocks just described; but they are in the greatest abundance in these, and prevail most in the Township of Clinton, near the village of Beamsville, where an attempt has been made by Mr. Lee to establish a lead mine upon what has been supposed to be a lode, on the property of Mr. Robert Comfort, on the 8th concession. The position of the supposed lode is in one of the many open joints or fissures by which these rocks are intersected throughout their whole range, from Queenston to Nottawasaga. In the locality in question the opening is again crossed by smaller cracks, and the walls of these are covered with crystals of pearl-spar and galena. The crystals of galena are doubtless in very great abundance; indeed there is scarcely the smallest part of the rock that does not contain them, and I do not think they were wholly absent from any fragment which came under my hammer in the neighbourhood. It is doubtful to me, however, that there are any evidences of a lode of the ore. Metalliferous lodes, according to the generally received opinion, are deposited in faults or the open cracks, resulting from the fracture and dislocation of the strata through the influence of disturbing forces, which have caused the mass of rock on one side of the plane of fracture to slip on that on the other. The movement brings opposite to one another parts that do not fit, hence a space which gives an opportunity to the subsequent deposit of the earthy and metalliferous materials which constitute a lode. It is generally in districts where movements are indicated by highly inclined strata or an irregularity in the dip, that such faults exist, and when the lode is not immediately presented to the eye, an evidence of its probable position would be an observed interruption in the continuity of the beds. Now here the rocks are perfectly horizontal, and have no appearance whatever of having been disturbed since the time of their deposition. There is no slip or want of continuity in the strata, and where the space between the walls of the joint is filled up, it is with drift, and not with calcareous spar or such mineral matter as would occupy a fault, veins of which are singularly absent; so that the open joints must owe their origin to some other cause, and it is in the walls alone that the galena is present.

Mineral springs are not unfrequent in the rocks of the deposit. The waters of one in the neighbourhood of Ancaster, qualitively analysed, yielded a large proportion of sulphate of magnesia.

9. RED SHALES.

These shales are the same as a deposit described by Mr. Hall, in the fourth geological district of New York. Little can be said of them at present, as I have never yet seen them in place, but there is nevertheless no doubt of their existence, although they are probably of small thickness and minor importance. Their presence is indicated by the colour of the drift between the Falls of Niagara and Waterloo, and between Allensburgh and the Junction on the Welland Canal, and their position made certain by the place they occupy in the State of New York, immediately across the Niagara River.

10. GYPSIFEROUS SHALES.

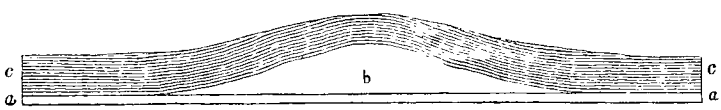
Commencing at the Niagara River, the upper beds of this series are seen near the village of Waterloo, between which and Chippawa the whole country is enveloped in drift clay, but it is probable the lowest beds are somewhere in the neighbourhood of the latter place. The deposit extends from this in a westerly direction to the Grand River, and the line of strike appears to coincide with the course of the stream for a considerable distance up towards its source.

Inclusive of the subjacent red shales, I have estimated the thickness of these rocks to be 300 feet. They are composed throughout of limestones and calcareous shales, in one or perhaps two parts of their vertical extent containing gypsum in detached masses, which are sometimes of large extent. Wherever these are known they are greatly worked, and the material at all times commands a ready market for agricultural purposes.

The limestones are frequently of a drab colour, and are deposited in beds seldom exceeding a foot in thickness. They are hard and compact, and remarkable for the numerous small cavities they contain. A bituminous matter often fills these cavities, and in thin layers divides the beds. Sometimes the limestones are of a blue colour, in which case they never have either of the above peculiarities; and sometimes the rock has more the nature of a calcareous slate. The drab variety is the best adapted for all economic purposes, and makes excellent lime. The shales when exposed to the effect of the weather are generally of a greenish colour, but when the action of the atmosphere has not reached them they are usually dark brown. They are argillaceous, and in almost every instance where the gypsum occurs to any extent, it is overlaid by them. Beds fit for the purposes of hydraulic cement occasionally occur, interstratified with the limestones and shales, and in one place in particular, about three and a half miles below Cayuga, on the Grand River, a hard solid bed of water-lime exists, which attains a thickness of probably thirty feet.

The gypsum is deposited in detached masses, never in continuous strata, and either through some peculiarity in its original deposition or some remarkable movement afterwards, it almost invariably assumes more or less a conical shape,—the strata by which it is covered being bent or arched over it, thus:—

Fig. 2.

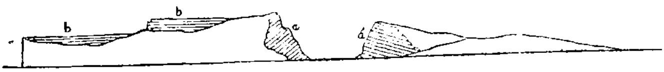


a Limestone.
b Gypsum.
c Green shales.

These masses vary in the diameter of their bases from a few inches to many yards. It sometimes happens that a mass is so very extensive horizontally, that the first impression may lead to the belief that it is as continuous as the strata covering it; but this is never confirmed by careful examination. Wherever the deposits have been much worked, the upper surface has been found at last to slope rapidly down, followed by the superincumbent strata, and wherever I have yet seen them the thickest part has been about the point where their centre might be assumed to exist. The conical shaped hills or hillocks for which the gypseous country is remarkable, owe their origin to the peculiarity of the deposits of gypsum, and they are generally considered a certain indication of the subjacent presence of the mineral. The disturbance which the higher parts of the formation occasionally appear to have sustained is probably attributable to the same cause. In the Township of Dunn, near the little village of Haldimand, in several places, are instances of considerable disturbance, and it is probable that the following diagrams will better illustrate the relation they bear in form to the deposits of gypsum than further description. It must be borne in mind, however, that notwithstanding the comparatively slight contortions which are occasionally met with, the formation, as a whole, is as horizontal as those it rests upon.

The following diagram represents a quarry which has been opened for limestone in the neighbourhood alluded to:—

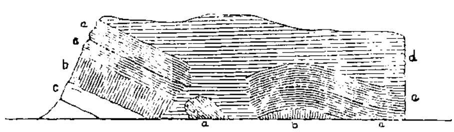
Fig. 3.



a Limestone dipping E. < 32°.
á Limestone dipping W. < 10°.
b Sandstone overlying with apparent but probably not real want of conformity, and belonging to the next series.

In the Welland Canal at the Broad Creek branch, Mr. Keefer, one of the Engineers, describes an excavation to have passed through rocks whose attitude somewhat resembled the masses represented in the following sketch:—

Fig. 4.



a Chert rocks.
b Water lime.
c Gypsiferous limestone.
d Clay.

The cherty rocks indicated belong to the next superior series, and to the same as the sandstone in the previous diagram.

Mr. Keefer was so kind as to supply me with another section of a locality on the Junction Canal between Port Colborne and Rama bend, which likewise fully illustrated these undulations, and in this case as in the others a higher series of rocks has been affected, most probably by the same cause.

The beds of gypsum that have been hitherto worked and have come under my observation are those of Mr. Case, about three and a half miles below Cayuga on the Grand River; of Mr. Donaldson, nearly opposite the village of York on the same river, and two beds mined near Paris, one by Messrs. Curtis and Coleman, and the other by Mr. Tennant.

The bed worked upon Mr. Case's property has not been long in operation, but it appears likely to prove one of great extent and of immense value. There seem to be evidences of its occupying an area of nearly sixty acres, and being on the navigable part of the

Grand River, it enjoys the advantage of an easy export to distant places, in addition to a daily increasing local demand. The thickness of the bed where it is worked is four or five feet, and in a well sunk near the proprietor's house, a thickness of twenty feet of water-lime, with a considerable quantity of gypsum intermixed, is passed through below the main bed, which there measures about six feet, while between it and the bottom of the well there is an additional three or four feet of water-lime. The upper gypsum is of a pure white, and of the best description, and if it turn out to occupy as great an area as appearances indicate, it cannot fail to be the source of a large revenue to its owner. Should the public works extend at any future period to the establishment of a canal on the Grand River, the water-limes in the neighbourhood of Mr. Case and elsewhere, associated with gypsum beds, will be of importance as available in the construction of the locks and dams connected with it.

The next bed of importance is near York. Part of it is worked by Mr. Donaldson, and part by Mr. Cook, the proprietor. It measures at the outcrop on the Grand River bank three and a half feet in thickness, and increases advancing along the level. It has been extensively mined, and the material is of excellent quality, though it is not generally said to be equal to that of Mr. Case. An argillaceous limestone, approaching to a shale, overlies the gypsum, and it might be applicable for hydraulic purposes, but it is not sufficiently thick to be of any great importance.

The beds at Paris are likewise extensive, and that of Messrs. Coleman and Curtis is largely mined. That belonging to Mr. Tennant is but recently opened, but at the time of my visit the proprietor had every reason to anticipate a successful issue to his undertaking.

The value of gypsum, as applied to agriculture, is well known. The material is becoming every day more generally used, and as the country is purely agricultural it is a matter of primary importance to know how far we can depend upon our own resources for the sufficient supply of an increasing demand. The beds mentioned above would probably have remained unknown to this day, had not the Grand River, by intersecting their outcrop, partially exposed them, and it is only at such places that they have hitherto been worked, and their probable extent suspected. The Grand River, nearly from its source to its mouth, probably runs in the strike of the formation, and consequently on the same series of rocks the whole way, so that there may be many masses of gypsum on its banks above as well as below Paris. But it is not, therefore, to be supposed that the mineral is exclusively confined to the immediate margin of the stream, and it would be highly advantageous that a judicious system of boring should be adopted, where gypsum is supposed to exist, and where the usual indications of its presence exhibit themselves. I was informed by Mr. Jackson, the Engineer to the Grand River Navigation Company, that several places had been bored on both sides of the river without success. It is likely, however, that in some cases the site for the bore hole was injudiciously chosen, and that in others a sufficient depth had not been penetrated. Moreover it is possible that in some instances the boring rod may have passed within a few inches of the mineral, and pierced only the shales and limestones by which the precipitous side of the mass is covered, and while the work, has in consequence, been abandoned, a new bore hole let down within a few feet of the first, might have struck upon the gypsum at a smaller depth. As an example of the form of a mass which might lead to such results I may mention that at Caledonia, on the property of Ronald McKinnear, Esquire, (to whom I am much indebted for attention and hospitality,) there is a mass of gypsum which though only a few feet in diameter is nevertheless of considerable thickness, and is overlaid by the usual conical hummock. Now it is not difficult to see that had this been entirely concealed, and an attempt made to hit it by boring, the rods might have penetrated all around without once touching the mineral, as it is only a small central part, or the nucleus of the hummock which contains it. As it happened, this mass being exposed on the banks of the river, boring was unnecessary, and the bed proved to be of little extent; but it serves to show how the edge of a more important one might be missed, while the borer might come very near it. In making such attempts, nothing is more requisite on the part of the person entrusted with the work than a thorough knowledge of all the strata of shale and limestone, both above and below the usual position of the course of gypsum masses, and he should be particularly acquainted with any of the more remarkable beds, as regards their quality and distance from one another, in order that, as the rod went down, he might at once, from the nature of the borings, be able to pronounce what part of the series associated with the gypsum had been touched. This knowledge, of course, could only be arrived at by careful preliminary study of the whole formation, wherever it may have been exposed by natural sections or by mining operations.

Many mineral springs exist upon this formation. Among them the most remarkable yet known is the " Sour Spring " on the Indian Lands, at a distance of ten or twelve miles south from the town of Brantford, to the west of the Grand River. A specimen of this water has been procured, but has not yet been subjected to analysis. It is said by the inhabitants to have useful medicinal qualities, and to have been resorted to by people in the neighbourhood with great advantage. It appears to possess antiseptic properties. Vegetable matter which is several feet in thickness on the surface round the spring, has the appearance of tan-bark, as if it had been arrested in its progress to decay, and preserved by the chemical effects of the water or of the gasses evolved from it.

Salt and sulphurous springs are known in several localities, and it is not improbable that in some instances the former may prove of importance as it is generally supposed that salt and gypsum accompany each other, and as it is known that the very valuable salt manufactories of Onondaga, in the State of New York, are located on the rocks associated with the formation.

Throughout the whole of these rocks, in so far as I have yet seen them, I have not met with one solitary fossil; still as organic remains are reported to have been found in Wayne County, in the State of New York, in the same series, it is probable they may yet be detected in some localities. There is indeed a limestone rock which is worked near Haldimand, and used for *backing* stones, and which is seen in several places on the shores of Lake Erie, that contains fossils. Specimens of it were procured and sent to Montreal, but I am yet undecided whether they ought to be classed with the gypseous rocks or with the upper limestones which succeed them.

11. UPPER LIMESTONES.

This is the highest series of rocks that has yet come under my observation. They may be seen at Fort Erie on the Niagara; at Port Colborne, and almost any part of the coast of Lake Erie, to the mouth of the Grand River; and beyond it, according to information derived from several inhabitants, as far as Dover in the

Township of Woodhouse. They are likewise visible through the newly formed township of Cayuga, formerly belonging to the Indian Reserves, near the Grand River; on the Talbot Road, and on the banks of the Thames in the Township of West Oxford, in the Brock District.

Wherever I have hitherto seen the lower beds, they are almost exclusively composed of chert or hornstone, frequently containing vast quantities of iron pyrites, and sometimes possessed of beautiful specimens of fluate of lime. Resting on these cherty rocks there is a sandstone, which, though of very different character in different localities, appears to be continuous in so far as I have examined. This is again overlaid by a limestone which is the uppermost rock of the present section, and the highest I have yet seen in Western Canada.

The sandstone is not seen at Fort Erie or at Port Colborne, but silicious limestones exist there, which are probably its equivalent. In the township of Dunn near Haldimand, sections of this sandstone are visible, resting on beds of chert, which overlie the gypseous limestones. It is here frequently made up of large angular pieces of hornstone, which, with the numerous large corallines, and other fossils it contains, render it almost useless as a building stone. Captain Murray, a contractor on the Grand River, had quarried it in several places, but finding it totally unfit for the purposes he intended to apply it to, he abandoned it.

In the Township of Cayuga, particularly on lots 45 and 46, on the town-line north of the Talbot road, this sandstone is largely developed, and is capable of being quarried along the surface of the ground for an immense extent. It is composed of small grains of quartz, in some instances so closely cemented together as to assume the appearance of white compact quartz rock. At other times it is made up of coarser particles, in which case it disintegrates by exposuse to the weather. The beds are massive, being one to three feet in thickness; they have the appearance in many places of being well adapted for building purposes, and an almost endless quantity of the stone is easily attainable. It was at one time proposed by Mr. De Cew, a proprietor and resident here, to establish a glass factory, for which he conceived the sandstone, as likewise the chert rocks below, would be available. It is by no means unlikely that the sandstone would in some places be found eligible for the purpose. Mr. De Cew's project, however, not receiving sufficient support, seems for the present to be abandoned. The corals and other fossils which abound in the upper limestone begin to appear in this sandstone.

Over this sandstone in Cayuga the true upper limestones are seen capping small eminences which stand upon it as a base. These limestones, wherever known, abound in a vast variety of fossils, especially corals, the whole surface of the ground in many places where they exist being literally covered with them. I collected numerous specimens at Port Colborne through the township of Cayuga and in several parts of the District of Brock. The rock is in general bituminous, and has a very peculiar odour when broken, arising from the presence of naptha. This substance is frequently found in small cavities, and in some instances might be collected in sufficient quantity to afford a specimen of its nature. These cavities are of common occurrence at Greybril's quarry near Gravelly Bay, where the rock is largely quarried for building the magnificent lock on the Broad Creek branch of the Welland Canal.

I was informed by Mr. Cull, an Engineer, that below London the naptha is occasionally found floating upon the surface of the pools or stagnant waters of the Thames, and is frequently collected by means of a cloth.

Sulphureous springs are of frequent occurrence on this formation, and iron pyrites, from the decomposition of which they probably derive their quality, is in some places very abundant. One of these springs exists on the property of Mr. Rouvière, near the village of Beechville in West Oxford.

POST-TERTIARY AND ALLUVIAL DEPOSITS.

It cannot but have struck every one who has travelled over the western part of Canada, that nearly the whole of it is very much covered and concealed by a vast deposit of soft or loose derivative material, and it is only where the country is intersected by rivers or on lake shores, or in that mountain ridge which extends from Queenston to Hamilton, and thence to Nottawasaga Bay on Lake Huron, that an outcrop of the older stratified rocks is to be seen.

In the district which has on the present occasion been more immediately the subject of my investigation, the deposit consists of various beds of clay, sand and gravel, interspersed with large boulders; the thickness it attains is generally very considerable, and frequently reaches 200 or 300 feet. The clay cliffs of Scarborough are 320 feet. The Central Ridges, as they are called, running parallel to the north shore of Lake Ontario, are probably 200 or 300 feet, and the highlands in Oxford are frequently 100 or 200 feet and even more, and the banks of the Grand River often expose a very considerable amount.

As to the sources whence the material is derived, the finer parts, considered by themselves, present less evidence than the coarser. The clay gives no evidence at all. In some portions of the sand, however, magnetic iron ore exists, as on the shore of Lake Ontario at Toronto, where the quantity is so considerable on Gibraltar Point, that if a magnet be thrust into the arenaceous detritus composing it, on being withdrawn, it will be found covered with small grains of the ore. The origin of this is probably the primary region where magnetic iron ore abounds. The evidence of the gravel and coarser material is more direct. The calcareous pebbles in the country on the south shores of Lake Simcoe are identical with the limestones of Rama to the north, and their fossil, as well as their mineralogical character, is an incontestible proof of the source from which they are derived. The testimony of fossils is brought to bear also in the district of country separating Lake Ontario from Lake Erie, and by them it is readily determined that the coarser detritus reposing on each successive formation, is made up with the addition of whatever is of primary origin, of material derived from the formation itself, or of the ruin of some lower deposit, whose outcrop is to the north, or of a mixture of both. The ruins of southern outcrops never repose on northern formations for great distances; and only occasionally for short ones, where the southern outcrop occupying an elevated position in an escarpment, the northern deposit stands at a lower geographical level. Instances of this last condition may be seen on the flank and at the base of the ridge skirting the south side of the lake, where fragments of the Niagara limestones which constitute its summit may frequently be found resting on the red marls lower down. But on the contrary high up the side of the mountain in the same range, 110 feet above the lake level, often may be encountered the remains of the subjacent blue shales, whose outcrop is either buried beneath the waters of the lake or must be looked for on the opposite shore; and though the fragments of this individual formation may not extend to the margin of Lake Erie, the detritus resting there upon the upper limestones consists chiefly of thier own debris, with that of the gypseous series to the north. The great erratic blocks or boulders when rounded by distant travel, are almost all of primary origin, and the evidence they present is in unison with that derived from the gravel and sand, to prove that at some remote period, the surface has been covered with water, having a current from the north.

As bearing upon the probable direction of this current, it may be mentioned that in several places between Niagara and Hamilton, along the mountain or Ridge which has been alluded to, where the drift has been removed, the rock beneath has been found to present a smooth and almost polished condition, with a gently undulating surface, marked by deep parallel grooves and scratches whose general direction is from north to south. These grooves are well displayed in the quarry of Mr. Kifler, at Thorold.

Another instance of an action coming within the recent or post-tertiary epoch, is to be found in the valley of the Nottawasaga River. The head of this valley is in Albion Township, where the Central Ridges separate it from the valley of the Humber, the waters of which, flowing in the same line, take precisely an opposite course, the latter falling into Lake Ontario, while those of the former are emptied into Lake Huron. The valley is broad, and on the west side it is bounded by an escarpment formed in the lower part of the red marls and sandstones, with the gray band strongly marked above them, and crowned by the overlying limestone, of which the Niagara rock constitutes the summit. From the margin of the stream in the centre of the valley, a gentle rise over a breadth of twelve to thirteen miles, reaches the foot of the escarpment, and after a short and sharp ascent or talus on a portion of the red marls, the solid limestones present perpendicular precipices rising at once or in successive steps. From this side of the valley the main trunk of the river is supplied by many tributaries, and the west branch of the main stream itself takes its origin upon it. But though the summit or edge of the escarpment exhibits the range of highest points in the valley, and the dip of the strata is westward, a direction opposite to that of the tributaries, the water shed which divides these from the streams that empty themselves into Lake Erie and the southern part of Huron, is lower land three to nine miles west of the escarpment, lying on the back of the calcareous strata which form its upper part. And it is through deep and narrow ravines cut clean through the solid limestone, and far down into the softer red marls below, that the waters of the intermediate land find an outlet to the valley. It is in the neighbourhood of these ravines that the phenomena I have reference to exist. They afford scenes of the wildest and most picturesque confusion; great blocks and fallen masses of the limestone, which in many places is seen towering 200 feet above, lie scattered over the bottom of the gorge, while others constitute a talus at the base of the precipices, as if, to form it, a whole cliff had been shaken into mighty fragments, among which are holes and interstices so numerous, large and deep, that it is dangerous to pass along. Great impending masses of the perpendicular cliffs themselves, comprising occasionally an acre, cracked off from the main body of the rock, dip slightly in towards the Ravine, and the rents which separate them from the solid strata with a width of twenty or thirty feet, are sometimes so profound, that a great pine tree 120 feet in length, which blown over by the wind, has fallen obliquely into the crevice, will be seen hanging head downwards in it, still attached by some unbroken part of its roots to the edge of the chasm, the bottom of which is hid in darkness below the other extremity. The rents appear to be generally in the natural joints of the rock, their sides are quite smooth and even, and while a main one will separate an acre from the mountain, many minor ones, running usually in two parallel directions, will divide the acre into several rhomboidal parts. Some of the tributaries may run through ten miles of their course in these ravines, and though their turbulence and velocity is usually so great during freshets that one of them is appropriately termed the Mad River, the quantity of water they possess cannot be considered sufficient to have produced the effects observed; and this is corroborated by the circumstance that dislocated masses are not wanting in those parts of the escarpment which exist between the tributaries and face the general valley.

The valuable materials which belong to these deposits are bog iron ore, calcareous tufa, shell marls, brick and coarse pottery clays, glazing sand, fuller's and ochrous earths.

Mention has already been made of localities in which most of these materials occur in the line of section which has engaged my attention, and I have only further to add, that a great deposit of clay about to be used as fuller's earth, is to be seen on the Sixteenmile Creek at Mr. McKann's mills, in the Township of Nassagaweya. Being derived from the red marls, its colour is red, and, mixed with oil, it has been found very serviceable used as paint. The same material occurs on the Mad River in Nottawasaga, and it is very probable that it may be discovered in many places along the outcrop of the formation to which it owes its origin. An ochrous earth likewise exists in some places, which has been found available as a yellow paint; but though I have seen it used I did not meet with any of it in situ.

I have the honor to be,

Sir,

Your most obedient Servant,

(*Signed*,) ALEXANDER MURRAY,

Assistant Provincial Geologist.

APPENDIX.

Section of the Nova Scotia Coal Measures, as developed at the Joggins, on the Bay of Fundy, in descending order, from the neighbourhood of the West Ragged Reef to Minudie reduced to vertical thickness.

1.	Ft.	In.
Greenish gray or drab coloured sandstone or grit, with some conglomerate beds, of which the matrix is sandstone and the pebbles consist of white and of red veined quartz. These are generally as large as peas; some are of the size of pigeons' eggs, and a few as large as hens' eggs,	30	0
Drab sandstone of a fine grit, but rather too hard for grindstones, ...	2	0
Red or chocolate coloured argillaceous shale, with small layers of sandstone of the same colour and quality as above, ...	15	0
Drab sandstone, with small layers of chocolate coloured shale, ...	20	0
Dark red argillaceous shale, with some green spots,	10	0
Drab sandstone in two to three beds, ...	8	0
Drab sandstone of a coarse grit; the bed has an uneven bottom, ...	20	0
Dark red or chocolate coloured argillaceous shale, with a few bands of sandstone, ...	20	0
Dark red argillaceous shale, ...	10	0
Drab sandstone, ...	7	0
Dark red shale and drab sandstone in irregular beds,	20	0
Drab or greenish gray sandstone, ...	3	0
Red argillaceous shale, ...	9	0
Greenish gray or drab coloured sandstone in several layers, separated by bands of dark red or chocolate coloured argillo-arenaceous shale, ...	20	0
Greenish gray or drab coloured sandstone of a fine grit, ...	4	0
Soft measures, concealed, probably dark red shale, ...	20	0
Coarse greenish gray sandstone, or rather a conglomerate with a fine matrix of sand and with fragments of plants, converted into coal, ...	30	0

Measures not well seen, ...	15	0
Greenish gray sandstone, with conglomerate beds and plants converted into coal, ...	60	0
Dark red shale, ...	15	0
Greenish gray sandstone, with conglomerate beds, ...	10	0
Dark red shale, ...	5	0
Greenish gray or drab coloured sandstone, with conglomerate beds, ...	15	0
Dark red shale, ...	10	0
Greenish gray sandstone, with conglomerate beds, ...	52	0
Dark red shale, with bands of red sandstone, ...	14	0
Greenish gray sandstone, with conglomerate beds, ...	25	0
Dark red shale, ...	10	0
Greenish gray sandstone, with plants converted into coal, ...	30	0
Dark red shale, with thin beds of sandstone, ...	10	0
Greenish gray sandstone, with thin conglomerate layers, ...	3	0
Dark red shale, ...	6	0
Greenish gray sandstone, with beds of conglomerate,	55	0
Dark red or chocolate coloured shale, ...	1	0
Greenish gray sandstone, with much conglomerate and fragments of drift plants coated with coal,	50	0
Dark red or chocolate coloured shale, ...	9	0
Greenish gray sandstone, with conglomerate beds and carbonized drift plants, ...	14	0
Dark red shale, ...	5	0
Dark red shale, with beds of sandstone, ...	15	0
Greenish gray sandstone, with conglomerate beds, ...	20	0
Greenish gray sandstone, with bands of red shale, ...	21	0
Greenish gray sandstone, with conglomerate beds and carbonized drift plants of large diameter, say one foot, and wholly converted into coal. In many casesthe action of the surf against the base of the perpendicular cliff has worn deep holes or caverns, where the stems lie prostrate in the rock. The plants are *sigillariæ*, so are nearly the whole of those already mentioned as met with in the grits or conglomerates. Fragments of *calamites* are occasionally seen, ...	30	0
Red or chocolate coloured shale, ...	10	0
Greenish gray sandstone of a conglomerate character, with many carbonized drift plants imbedded in it. Some beds of grit in this, towards the bottom, have been found fit for grindstones, ...	20	0

Dark red or chocolate coloured argillaceous shale, ...	60	0
Greenish gray sandstone inclining to yellow, chiefly of a coarse grit and free texture; some of it must be called conglomerate, the pebbles of which, consisting of quartz of various colours—white, yellow, and red, with black chert and lydian stone,—are some of them as large as hens' eggs, a great many as large as almonds, and the majority as big as peas. Some of the beds have been found fit for grindstones. This sandstone constitutes the point of West Ragged Reef, ...	30	0
Measures concealed, ...	42	0
Measures concealed, with sandstone at the bottom,	23	0
Greenish gray or drab coloured sandstone of a coarse grit, ...	12	0
Dark red shale with green bands, ...	30	0
Greenish gray sandstone of a coarse grit, some of which is fit for grindstones, but some parts are conglomerate, with red and white quartz pebbles, generally as large as peas, some of the size of pigeons' eggs, and a few as large as hens' eggs; some parts exhibit large spherical concretions rather harder than the surrounding material, ...	30	0
Dark red shale, with green bands, ...	6	0
Greenish gray or drab coloured sandstone of a coarse grit, ...	6	0
Dark red and light green shale, with some bands of drab sandstone, ...	50	0
Greenish gray sandstone of a coarse grit, ...	30	0
Dark red shale, ...	30	0
Greenish gray sandstone of a coarse grit, with some carbonized drift plants, ...	3	0
Greenish and red shale. This is on the west side of South Brook, Two Rivers, ...	3	0
Measures not well seen, being occupied by the brook, but consisting chiefly of greenish gray sandstone,	42	0
Greenish gray sandstone, with bands of greenish arenaceous shale and red arenaceous shale, ...	10	0
Red argillaceous shale, ...	1	0
Greenish gray sandstone, ...	7	0
Red arenaceous shale, ...	4	0
Red argillaceous shale, ...	6	0
Red argillo-arenaceous shale, ...	17	0
Greenish gray sandstone, ...	2	0

Red argillo-arenaceous shale, ...	2	0
Greenish gray sandstone, ...	1	0
Red argillo-arenaceous shale, ...	18	0
Greenish gray sandstone, ...	7	0
Red argillo-arenaceous shale, ...	6	0
Greenish gray sandstone, ...	1	0
Red argillo-arenaceous shale, with green bands, ...	8	0
Greenish gray sandstone of a coarse grit, ...	19	0
Measures concealed. This is where the North Branch of the Two Rivers occurs, ...	16	0
Greenish gray sandstone of a coarse grit, with some beds of conglomerate, having red and white quartz pebbles, the largest of which would weigh about two ounces, ...	20	0
Red argillaceous shale, ...	12	0
Greenish gray sandstone of a coarse grit, some parts of which are fit for large grindstones, commonly called *water-stones* by the quarrymen, ...	76	0
Greenish gray sandstone, with divisional layers of arenaceous shale, ...	4	0
Red argillaceous shale, ...	19	0
Red argillaceous shale, with greenish gray arenaceous shale at the top, ...	19	0
Greenish gray sandstone, ...	1	0
Red argillaceous shale, ...	4	0
Greenish gray sandstone, ...	2	0
Red argillaceous shale, ...	6	0
Greenish gray sandstone, ...	5	0
Red argillaceous shale and green arenaceous shale, with a few bands of greenish gray sandstone. This deposit is chiefly red shale, ...	32	0
Greenish gray sandstone, ...	24	0
Red argillaceous shale with green bands, ...	10	0
Greenish gray sandstone in four beds, separated by bands of red argillaceous shale of one to two feet thick, ...	27	0
Red argillaceous shale, ...	11	0
Greenish gray sandstone, with one foot of shale towards the bottom, ...	5	0
Red argillaceous shale, ...	8	0
Greenish gray sandstone in three small beds separated by red shale; occasionally the sandstone occupies the whole of the thickness, ...	5	0
Red argillo-arenaceous shale, with green bands, ...	27	0
	1617	0

RECAPITULATION.

Greenish gray or drab coloured sandstones, with conglomerate beds and large carbonized drift plants, ...	947	0
Dark red or chooclate coloured argillaceous and argillo-arenaceous shales, ...	670	0
	1617	0

2.

Gray arenaceous shale, ...	5	0
Greenish gray sandstone. This is an unequal band, and there are doubtful indications of the leaves of *stigmariæ ficoides* at the top, ...	8	0
Reddish and greenish gray argillaceous shale, with some bands of arenaceous shale, ...	28	0
Greenish gray sandstone of a coarse grit, fit for water-stones, ...	7	0
Red argillaceous shale, with some bands of arenaceous shale, ...	5	0
Measures concealed, ...	26	0
Greenish gray sandstone, ...	3	0
Measures only partially seen, and containing some arenaceous shale, ...	13	0
Reddish yellow sandstone, ...	2	0
Measures concealed, but shewn by the shape of the surface to be soft, ...	4	0
Reddish yellow sandstone of a coarse grit, fit for water-stones, ...	15	0
Red argillaceous shale, ...	7	0
Reddish yellow sandstone of a coarse grit, fit for water-stones, ...	12	0
Red argillaceous shale, with greenish gray arenaceous shale in three beds, ...	47	0
Greenish gray sandstone, ...	7	0
Red argillacoous shale, ...	3	0
Greenish gray sandstone, ...	14	0
Dark green shale, ...	1	0
Gray sandstone, ...	25	0
Red argillo-arenaceous shale, with greenish gray arenaceous shale, and some few layers of sandstone,	42	0
Greenish gray sandstone, ...	9	0

Greenish gray arenaceous shale and sandstone, with red and gray argillaceous shale, ...	24	0
Red argillaceous shale, with green arenaceous shale,	26	0
Gray sandstone fit for grindstones, ...	21	0
Red and green shale, ...	11	0
Greenish gray sandstone, ...	4	0
Red argillaceous and arenaceous shale, ...	5	0
Greenish gray sandstone of various qualities, chiefly of coarse grit, fit for large grindstones or water-stones; much of it, however, is fine enough for small stones; both are made from the Reef, ...	97	0
Red argillaceous and greenish gray arenaceous shale,	13	0
Gray sandstone fit for grindstones, the bottom part of a coarse grit. This constitutes Ragged Reef Point, ...	35	0
Red argillaceous shale, ...	15	0
Greenish gray sandstone, fit for grindstones, ...	10	0
Red argillaceous shale, with one foot of greenish gray sandstone, ...	9	0
Greenish gray sandstone fit for grindstones; the top of the bed is uneven, ...	20	0
Red argillaceous shale, gray arenaceous shale, and a few bands of greenish gray sandstone, ...	15	0
Red argillaceous shale, ...	4	0
Greenish gray sandstone, ...	2	0
Red argillaceous shale, with green bands, ...	13	0
Greenish gray shaly sandstone, or perhaps arenaceous shale, ...	7	0
Greenish gray sandstone fit for grindstones, with a few *calamites* nearly at right angles to the plane of the beds, as if in situ, but forced over at the top, ...	36	0
	650	0

RECAPITULATION.

Drab coloured sandstones without conglomerate beds, ...	219	0				
Gray sandstones, ...	81	0				
Reddish yellow sandstones, ...	28	0				
			328	0		
Red, green, and greenish gray argillaceous and arenaceous shales, ...			322	0		
					650	0

(Indications of *stigmariæ ficoides* exist near the top, and of upright *calamites* at the bottom.)

B.

Black carbonaceous shale, ...	2	0
Greenish gray sandstone, with *stigmariæ ficoides*, (this would be called *understone* by the Welsh miners,)	3	0
Gray argillaceous shale, with impressions of *ferns* and other plants, (*topstone*,)	2	0
1. Coal of inferior quality—a regular seam, ...	0	1
Greenish gray argillaceous shale, with *stigmariæ ficoides* (*understone*), ...	1	0
Greenish gray argillaceous shale, with *stigmariæ ficoides* and *ironstone* balls (*understone*), ...	1	0
Greenish gray sandstone, ...	1	0
Red or chocolate coloured shale, ...	6	0
Greenish gray sandstone fit for grindstones, with a bed of red shale in the middle, ...	23	0
Red shale with a layer of sandstone, ...	12	0
Red shale in three beds, ...	5	0
Greenish gray sandstone in four beds, ...	6	0
Red argillaceous shale, ...	7	0
Gray sandstone in small layers, ...	7	0
Reddish gray sandstone, ...	3	0
Greenish gray sandstone in small layers, ...	7	0
Reddish and green sandstone, ...	13	0
Reddish and green shale, ...	1	0
Reddish sandstone—soft, ...	1	0
Red argillo-arenaceous shale, with balls of *ironstone*,	3	0
Red and green sandstone, ...	12	0
Measures concealed, but supposed to be soft, ...	52	0
Red and green shale, with balls of *ironstone*, ...	7	0
Gray sandstone and shale, ...	3	0
Greenish gray sandstone, ...	8	0
Greenish gray sandstone and red shale, ...	5	0
Greenish gray or drab coloured sandstone, fit for grindstones, ...	50	0
Red shale, ...	8	0
Greenish gray or drab sandstone, fit for grindstones, the top is uneven, and the whole is rather of a coarse grit. This constitutes South Ragged Reef, ...	20	0
Red shale, ...	7	0
Reddish gray sandstone, ...	9	0
Red argillaceous shale, ...	3	6

2. Coal, ...	0	1		
Dark gray carbonaceous shale, ...	0	4		
Coal, ...	0	1		
			0	6

Red shale; the upper part is of a tough quality, and has *stigmariæ ficoides* in it (*understone*), ...	13	0
Greenish gray or drab coloured sandstone, occasionally separated into two beds. This sandstone appears to thin out within the distance of 100 yards on the strike, ...	33	0
Red shale, ...	2	9
Greenish gray or drab coloured sandstone, ...	5	0
3. COAL, ...	0	1
Greenish gray sandstone and reddish shale, with *stigmariæ ficoides* (*understone*), ...	5	0
Reddish green argillaceous shale, ...	1	0
4. COAL, ...	0	2
Reddish and green argillaceous and arenaceous shale, the green colour prevailing, with *stigmariæ ficoides* (*understone*), ...	5	0
Reddish and green argillaceous and arenaceous shale, the red prevailing, ...	6	0
Red shale separated by thin bands of sandstone; the top is of the tough crumbly quality of underclay, but no *stigmariæ* are visible, ...	24	0
Gray sandstone and shale, the sandstone of soft quality, ...	11	0
Dark red shale, ...	0	6
Tough arenaceous shale, with *stigmariæ ficoides* in the upper part in two layers, a hard and a soft one, (*understone*,)	12	0
Red and green crumbly tough shale of the quality of underclay, but no *stigmariæ* visible, ...	11	0
Greenish gray sandstone, in four thinly laminated divisions, separated by red and green shale, ...	30	0
Gray sandstone and red shale in thin beds, ...	10	0
Red and green shale, ...	9	0
Greenish gray sandstone, with red and green shale,	4	0
Greenish gray sandstone, in regular beds of three feet and upwards, ...	17	0
Red shale, varying from two to seven feet thick, ...	5	0
Greenish gray sandstone, ...	4	0
Greenish shale, ...	1	0
Gray sandstone and shale, ...	4	0
Dark greenish red shale, ...	2	0
Greenish gray sandstone, ...	1	0
Dark green and red shale, ...	1	0
Greenish gray or drab coloured sandstone, fit for grindstones, forming a Reef, ...	25	0

Reddish shale, ...			8	0
Greenish gray sandstone in three beds, and gray shale in beds of one foot each, ...			20	0
Gray shale, with two beds of greenish gray sandstone of one foot each, ...			20	0
(Into the above penetrate two upright stems (*calamites*,) two inches in diameter; and replaced by sandstone with a coating of coal, they start from the top of the succeeding bed.)				
Dark gray argillaceous shale, ...			8	0
5. Coal, ...			0	2
Gray argillo-arenaceous shale (*fire clay?*) with *stigmariæ ficoides* (*understone*,)			1	6
Gray argillo-arenaceous shale, ...			10	0
Gray sandstone, ...			1	0
Gray arenaceous shale, in two equal beds, ...			7	0
6. Coal, ...			0	3
Gray argillo-arenaceous shale with *stigmariæ ficoides*, ...			2	0
Greenish gray sandstone, ...			2	0
Gray argillaceous shale, ...			1	0
Gray argillaceous sandstone, with *stigmariæ ficoides* (*understone*,)			2	0
Gray argillaceous shale, ...			3	0
Reddish gray sandstone, ...			1	0
Gray argillaceous shale, ...			1	6
(In this shale and running into the sandstone above, is visible a *calamite* at an angle of 45° to the plane of the deposit. It appears to start from the coal below.)				
7. Coal, ...	0	1		
Gray argillaceous shale, with *stigmariæ ficoides* (*underclay*,)	1	6		
Coal, ...	0	2		
Gray argillaceous shale, with *stigmariæ* (*underclay*,)	0	4		
Coal, ...	0	1		
			2	2
Gray argillaceous shale, with *stigmariæ* (*underclay*,)			2	0
Greenish gray crumbly sandstone, wtih *stigmariæ* at the top, ...			8	0
Red shale, ...			12	0
Greenish gray sandstone, ...			3	0
Red shale, with some few beds of sandstone, ...			20	0

Red shale and reddish gray sandstone, in beds of one to three feet, ...	12	0
Reddish gray sandstone, in thin layers alternating with red shale, ...	12	0
Red and green arenaceous shale, ...	4	0
8. COAL, ...	0	1
Gray argillaceous shale, with *stigmariæ ficoides* (*understone*,)	3	0
Gray argillaceous sandstone with *stigmariæ ficoides* (*understone*,)	2	0
Hard argillo-arenaceous shale with *stigmariæ ficoides* (*understone*,)	5	0
Red shale, ...	20	0
Greenish gray or drab coloured sandstone forming a reef, ...	20	0
Red shale, ...	23	0
Reddish gray sandstone, ...	5	0
Red shale and greenish gray sandstone; not much sandstone, ...	30	0
Red argillaceous shale and greenish gray sandstone, more sandstone than before, ...	30	0
Red argillaceous shale, ...	1	0
Reddish gray sandstone, ...	1	0
Red argillaceous shale, ...	3	0
Reddish gray sandstone, ...	2	0
Red argillaceous shale, ...	12	0
Greenish gray sandstone, ...	15	0
Red argillaceous shale, ...	20	0
Reddish sandstone, ...	2	0
Red and green shale, ...	8	0
Reddish gray sandstone, ...	6	0
Red shale, ...	2	0
Greenish gray sandstone, ...	2	0
Red argillaceous shale, ...	3	0
Greenish gray sandstone, ...	3	0
Greenish gray sandstone, fit for grindstones, which are now quarried from it. This constitutes North Ragged Reef, ...	12	0
Reddish gray sandstone in beds of one to three or four feet, separated by beds of reddish shale of one to two feet, ...	60	0
Red shale, ...	4	0
Reddish sandstone, ...	2	0
Red argillaceous shale, ...	20	0

Greenish gray sandstone in beds of two to three feet, with beds of red shale of one to two feet, ...			30	0
Red argillaceous shale, ...			6	0
Reddish sandstone separated at the top into moderate layers by red shale, ...			49	0
Red shale, ...			2	0
Reddish sandstone, ...			1	0
Red argillaceous shale, ...			35	0
Gray sandstone and red argillaceous shale in alternating beds, the sandstone has a reddish tinge towards the top, ...			30	0
Gray sandstone, ...			1	0
Reddish argillaceous shale, ...			5	0
Gray sandstone, ...			1	0
Reddish argillaceous shale, ...			5	0
Gray sandstone, ...			2	0
Reddish and gray shale, ...			1	0
Gray sandstone, ...			2	0
Reddish argillaceous shale with *ironstone* balls, ...			3	0
Gray sandstone, ...			1	0
Green and red argillaceous shale, ...			2	0
Hard argillo-arenaceous shale, ...			1	0
Gray argillaceous shale, with *ironstone* balls. This bed has something the appearance of underclay, but the *stigmariæ* are not distinct, ...			7	0
9. COAL, ...			0	3
Gray arenacious shale with *ironstone* balls, and *stigmariæ ficoides* (*underclay*,)			5	0
Reddish gray argillaceous shale, ...			1	0
10. COAL and *carbonaceous* shale, ...	0	8		
Gray argillaceous shale with *ironstone* balls and *stigmariæ ficoides* (*underclay*,)	2	0		
COAL, ...	0	2		
			2	10
Gray argillaceous sandstone with *stigmariæ ficoides* (*underclay*,)			2	0
Reddish and green argillo-arenaceous shale with *ironstone* balls. This has much the character of underclay, but the *stigmariæ* are not well marked, ...			12	0
Gray sandstone, ...			1	0
Gray argillaceous shale with *ironstone* balls, ...			3	0
Greenish gray sandstone, ...			4	0
Gray argillaceous shale, ...			1	0

(From the succeeding layer of coal there springs up an erect *sigillaria*. It is 1 ft. 6 in. in diameter, and penetrates the shale and sandstone above it, five feet of the plant being visible.)

11. COAL, ...			0	3
Gray sandstone with *stigmariæ ficoides* (*underclay*,)			2	0
Gray argillaceous shale, with *ironstone* balls and *stigmariæ ficoides* (*underclay*,)			5	0
12. *Black carbonaceous shale*, ...	0	9		
COAL, ...	0	2		
	——		0	11
Gray argillaceous shale, with *ironstone* balls and *stigmariæ ficoides* (*underclay*,)			1	6
Greenish gray sandstone, ...			1	6
Gray argillaceous shale, ...			9	0
13. COAL, ...			0	7
Gray argillaceous shale with *ironstone* balls and *stigmariæ ficoides* (*underclay*,)			2	0
Gray argillaceous shale, ...			5	0
14. COAL, ...	0	4		
Gray argillo-arenaceous shale with *ironstone* balls and *stigmariæ ficoides* (*underclay*,)	1	6		
COAL, ...	0	2		
	——		2	0
Gray argillaceous shale, with *ironstone* balls and *stigmariæ ficoides* (*underclay*,)			7	0
Gray argillo-arenacious shale with *ironstone* balls, and *stigmariæ ficoides* (*underclay*,) ...			1	0
Greenish gray sandstone, ...			1	0
Greenish gray sandstone and red and gray argillo-arenaceous shale. The sandstone is not in thick beds. *Ironstone* balls and *stigmariæ ficoides* are found through the whole deposit, ...			40	0
Greenish gray argillaceous shale, ...			3	0
15. *Carbonaceous shale*, ...	0	2		
Grey argillaceous shale, with *ironstone* balls and *stigmariæ ficoides* (*underclay*,)	1	0		
COAL, ...	0	1		
	——		1	3
Gray argillaceous shale, with *ironstone* balls and *stigmariæ ficoides* (*underclay*,)			3	0
Greenish gray sandstone with three bands of red and gray shale, loaded with *ironstone* balls, ...			12	0
Gray argillaceous shale, ...			1	0

16. COAL and *carbonaceous shale*,					0	2
Red argillaceous shale with *ironstone* balls and *stigmariæ ficoides* (*underclay*,)					7	0
Greenish gray sandstone,					10	0
Red and green shale,					2	0
Rough gray argillaceous sandstone,					2	0
Red and green shale,					2	0
Rough greenish gray argillaceous sandstone,					1	6
Red and green shale,					2	0
Greenish gray sandstone,					5	0
Red and green argillaceous shale,					7	0
17. COAL,			0	1		
Gray argillo-arenacious shale, with *stigmariæ ficoides* (*underclay*,)			4	0		
COAL,	0	4				
Carbonaceous shale,	0	4				
COAL,	0	1	0	9		
					4	10
Gray sandstone with 3 inches of soft gray argillaceous shale at the top, and penetrated by *stigmariæ ficoides* (*understone*,)					1	3
Gray argillo-arenaceous shale,					1	0
18. COAL,					0	3
Gray arnaceous shale with *stigmariæ* (*underclay*,)					2	0
Gray arnaceous sandstone with *stigmariæ* (*underclay*,)					2	0
Red and green shale,					3	0
Greenish gray sandstone in several layers,					6	0
Red and green argillaceous shale,					7	0
Gray sandstone with *stigmariæ* (*understone*,)					2	0
Red and green argillo-arenaceous shale,					4	0
19. COAL,					0	1
Red argillaceous shale with *stigmariæ* (*underclay*,)					4	0
Greenish gray sandstone and red shale alternating, the sandstone in 7 beds of 2 to 8 feet, the shale in 5 beds of ½ to 3 feet,					60	0
Red and gray argillaceous shale,					13	0
Greenish gray sandstone,					2	0
Greenish gray shale and sandstone,					2	0
Greenish gray sandstone,					2	0
Greenish gray shale,					2	0
Greenish gray sandstone,					2	0
Measures concealed,					41	0
Greenish gray sandstone,					1	0
Measures concealed,					1	0
Greenish gray sandstone,					2	0

Measures concealed. Here occurs Dennis River, ...	9	0
Greenish gray sandstone, ...	3	0
Measures concealed, but supposed to be shale, ...	4	0
Greenish gray or drab coloured sandstone, fit for grindstones. There are quarries in it on the South Reef, Dennis River, ...	25	0
Red argillo-arenaceous shale, ...	9	0
Greenish gray or drab coloured sandstone fit for grindstones. Some are quarried from the bed on the North Reef, Dennis River, ...	18	0
Measures concealed, but supposed to be argillaceous shale, ...	4	0
Greenish gray or drab sandstone, almost fit for grindstones, ...	14	0
Greenish gray argillaceous shale, ...	1	0
Greenish gray sandstone, ...	2	0
Dark gray argillaceous shale, ...	1	0
20. COAL, ...	0	1
Red and green shale with *stigmariæ ficoides*, (*underclay*), ...	1	0
Greenish gray sandstone, ...	1	0
Red and greenish gray argillaceous shale, with *ironstone* balls, ...	6	0
Carbonaceous shale, ...	0	3
Gray crumbly argillo-arenaceous shale, with *stigmariæ ficoides* (*underclay*), ...	2	0
Greenish gray sandstone, ...	1	0
Reddish shale, with *ironstone* balls, ...	1	0
Greenish gray sandstone, ...	4	0
Red argillaceous shale, with *ironstone* balls, ...	23	0
Greenish gray sandstone, with red and green shale studded with *ironstone* balls, ...	4	0
Red and greenish gray argillaceous and arenaceous shale, in beds of five feet, with greenish gray sandstone, in beds of one to three feet, ...	30	0
Reddish and greenish gray argillaceous shale, with *ironstone* balls, ...	15	0
Greenish gray sandstone, soft, with bands of red arenaceous shale, ...	21	0
Red argillaceous shale, ...	2	0
21. COAL, ...	0	2
Greenish gray argillo-arenaceous shale, with *stigmariæ* (*underclay*), ...	2	0
Measures concealed, ...	35	0
Greenish gray sandstone of good grit, ...	4	0

Measures concealed, ...	7	0
Greenish gray sandstone of good grit, ...	1	0
Measures concealed, ...	15	0
Greenish gray arenaceous shale, ...	1	0
Measures concealed, ...	43	0
Measures concealed, but probably sandstone, ...	7	0
Measures not perfectly seen, but consisting in part of greenish gray sandstone, ...	13	0
Greenish gray sandstone, with impressions and casts of *calamites*. This layer is almost fit for grindstones, but not sufficiently regular to be worked profitably, ...	13	0
Measures not well seen, supposed to be red shale, ...	22	0
Red and greenish gray argillo-arenaceous shale, the red prevailing, with some bands of greenish gray sandstone of six to twelve inches, ...	40	0
Reddish and greenish gray sandstone, in beds of three to ten feet, separated by layers of red and greenish gray arenaceous shale of one to two feet. This forms Dennis River Point, ...	31	0
Greenish gray sandstone, soft and ragged, in aggregated beds of one to ten feet; the aggregations separated by beds of dark red and green argillaceous and arenaceous shale of one to two feet, having *ironstone* balls; impressions of plants, among them *sigillariæ* and *calamites*, prevail in the sandstone, ...	60	0
Dark red and green argillaceous shale, with six beds of red and greenish gray sandstone; the shale is loaded with *ironstone* balls, ...	40	0
22. COAL *and Carbonaceous shale*, ...	0	2
Gray argillo-arenaceous shale of a tough quality, with *stigmariæ* (*underclay*), ...	4	0
Dark red and green argillaceous shale, with a band of sandstone, ...	16	0
Gray argillaceous and arenaceous shale, with *ironstone* nodules and some thin beds of sandstone,	10	0
Gray sandstone, with *stigmariæ* (*understone*), ...	2	0
Dark gray shale, with *ironstone* nodules, ...	22	0
Gray sandstone, ...	1	0
Gray argillaceous shale, ...	2	0
Gray sandstone, ...	1	0
Greenish gray arenaceous shale, ...	6	0
Gray sandstone, in layers of four inches each, ...	4	0
	2,134	1

RECAPITULATION.

COAL, in 22 seams, ...			5	5		
Carbonaceous shale associated with the coal seams, and in one instance without coal, ...			3	10		
					9	3
Underclay or understone, being beds of various material, immediately subjacent to the seams of Coal and Carbonaceous shale, and universally penetrated by the branches and radiating leaves of the stigmaria ficoides. Every one of the Coal and Carbonaceous seams rests upon a bed of this description, and in two cases stigmariæ beds exist without superincumbent coal. The material constituting the stigmariæ beds is as follows :						
Sandstone—Gray,	23	3				
Drab,	43	0				
			66	3		
Argillaceous and arenaceous shale, having often the character of fireclay—						
Gray, ...	58	4				
Greenish gray, ...	7	0				
Red and occasionally green,	42	0				
			107	4		
					173	7
Sandstone—						
Gray, ...	82	0				
Greenish gray chiefly fit for grindstones,	657	0				
Reddish of various shades, ...	204	0				
					943	0
Shale—Gray—Argillaceous,	92	6				
Arenaceous,	44	0				
			136	6		
Red and green—						
Argillaceous,	564	0				
Arenaceous,	104	9				
			668	9		
					805	3

Measures concealed, supposed to be chiefly shale, ...	203	0		
			2,134	1

(Among the organic remains visible are one oblique and two upright calamites, and one upright sigillaria. One top-stone bed of shale contains impressions of ferns.)

4.

1. *Bituminous limestone*, with *shells* and *fish*				
COAL, ...	1	0		
scales, ...	4	0		
			5	0
Greenish gray argillo-arenaceous shale, with *stigmariæ ficoides* (*underclay*), ...			4	0
Gray sandstone in courses of six and nine inches, with *ironstone* balls and *stigmariæ ficoides* (*understone*), ...			2	6
Gray argillaceous shale, ...			1	0
Gray sandstone, ...			6	0
Gray argillaceous shale, ...			1	0
Gray sandstone of a rough texture, ...			1	0
(From the succeeding bed springs an upright stem (*sigillaria*). It widens towards the bottom, and penetrates into the sandstone above.)				
Gray argillaceous shale, with *ironstone* balls, ...			6	0
Gray sandstone and arenaceous shale, ...			5	0
Gray arenaceous shale, ...			2	0
Hard gray arenaceous shale, with *stigmariæ ficoides* (*underclay*), ...			1	6
Gray argillaceous shale, ...			20	0
2. COAL and *Carbonaceous shale*, ...			1	0
Soft gray argillo-arenaceous shale, with *stigmariæ ficoides* (*underclay*,)			1	0
Hard gray arenaceous shale with *stigmariæ ficoides* (*underclay*,)			2	0
Gray argillaceous shale, ...			1	0
3. COAL and *Carbonaceous shale*, ...			0	3
Hard argillo-arenaceous shale, with *stigmariæ ficoides* (*underclay*,)			2	0

Gray argillaceous shale, ...					4	0
4. COAL, ...	0	9				
Carbonaceous shale, ...	0	6				
COAL, ...	0	1				
Carbonaceous shale, ...	0	4				
COAL, ...	0	1				
Carbonaceous shale, ...	0	8				
COAL, ...	0	2				
			2	7		
Gray argillaceous shale, no *stigmariæ* visible, but across the bed appear two parallel regular cracks, about ¼ of an inch wide each, and about 18 inches apart, filled with coal, the fibre of which is at right angles to the cracks. This may be the section of an upright stem, ...			1	7		
COAL, ...			0	8		
					4	10
Hard gray argillo-arenaceous shale with *stigmariæ ficoides* (*underclay*,)					4	0
Greenish argillaceous shale, with *ironstone* balls, ...					12	0
Gray sandstone in several layers, ...					1	0
Red and green argillaceous shale, with *ironstone* balls, ...					20	0
Gray sandstone and green shale in alternating layers,					24	0
Red or chocolate coloured argillaceous shale, ...					3	6

(From the succeeding bed rises an upright *sigillaria* one foot in diameter; two feet of it are seen penetrating the bed above.)

Gray argillaceous shale, ...			1	6
Gray sandstone in thin beds, ...			8	0
Gray argillaceous shale, ...			8	0
5. *Bituminous limestone*, with *shells*, ...	2	0		
COAL, ...	0	0½		
Gray argillo-arenaceous shale, with *ironstone* balls and *stigmariæ ficoides* (*underclay*,)	0	6		
Carbonaceous shale, ...	0	0½		
Gray argillo-arenaceous shale, with *ironstone* balls and *stigmariæ ficoides* (*underclay*), ...	1	6		

Carbonaceous shale, ...	0	1		
Gray argillo-arenaceous shale, with *iron-stone* balls and *stigmariæ ficoides* (*underclay,*)	2	6		
Coal, ...	0	6		
			7	2
Gray argillo-arenaceous shale, with *stigmariæ* leaves, (*underclay,*)			2	0
Gray arenaceous shale, with *stigmariæ* leaves (*under-clay,*)			6	0
Gray arenaceous shale and rough argillaceous sand-stone, ...			9	0
Greenish gray arenaceous shale, ...			5	0
Gray sandstone, ...			3	0
Red and green argillaceous shale with *ironstone* balls,			7	0
Gray rough sandstone, ...			17	0
Red argillaceous shale, with *ironstone* balls; thin beds of arenaceous shale and sandstone in the middle, ...			10	0
Red sandstone, ...			1	0
Red argillaceous shale, with *ironstone* balls, ...			1	0
Red sandstone, ...			1	0
Red and green shale, with *ironstone* balls and some arenaceous beds, ...			18	0
Gray sandstone, ...			2	0
Gray arenaceous shale, ...			4	0
Green and red shale, ...			3	0
Gray sandstone, ...			3	0
(From the upper part of the succeeding bed there arises an upright *sigillaria.*)				
Gray argillaceous shale, ...			17	0
Gray argillaceous shale, with a layer of sandstone,			3	0
Gray sandstone, ...			0	6
Greenish gray argillaceous shale, ...			17	0
Gray sandstone, ...			1	0
Gray argillaceous shale, with *ironstone* balls and a few bands of arenaceous shale, ...			17	0
6. *Carbonaceous shale,*	1	0		
Bituminous limestone, with *shells,* ...	0	10		
Coal, ...	0	4		
			2	2
Gray argillo-arenaceous shale, with *stigmariæ* (*under-clay,*)			2	0
Rough gray argillaceous sandstone, with the branches and leaves of *stigmariæ ficoides* (*underclay,*) ...			7	0

(An upright stem penetrating the above bed springs from the one below.)

Gray argillaceous shale, with *ironstone* nodules, ...			1	0
Gray sandstone, ...			1	0
Gray argillaceous shale, with *ironstone* nodules, ...			2	0
Gray arenaceous shale, ...			10	0
Gray sandstone, ...			3	0
Gray argillaceous shale, ...			2	0
Gray sandstone, ...			2	0
7. Coal, ...	0	10		
Carbonaceous shale, ...	0	2		
Coal, ...	0	10		
Carbonaceous shale, ...	0	2		
Coal, ...	2	0		
Coal and *Carbonaceous shale,* ...	0	6		
			4	6
Gray argillaceous shale, with *stigmariæ* (*underclay*,)			6	0
Gray argillaceous shale, loaded with a multitude of *ironstone* balls, ...			10	0
Gray argillaceous shale in beds of 1 to 3 feet, with sandstone and arenaceous shale in beds of 1 foot; *ironstone* nodules are very numerous in the whole, ...			20	0
Gray argillaceous shale, with *ironstone* nodules, ...			9	0
Gray sandstone, ...			3	0
Gray argillaceous shale, with *ironstone* nodules, ...			10	0
Gray sandstone, ...			1	0
Gray argillaceous shale, ...			2	0

(From the succeeding bed springs an upright *sigillaria* of 1 foot in diameter; the lower part commences to spread.)

Gray argillaceous shale, with *ironstone* balls and some sandstone, ...			2	0
Gray argillaceous shale, with *ironstone* balls, ...			5	0
8. Coal, ...	0	2		
Gray argillaceous shale, ...	0	4		
Coal, ...	0	3		
Carbonaceous shale and Coal, ...	1	3		
Coal, ...	0	1		
Gray argillaceous shale, with *ironstone* balls and *stigmariæ* (*underclay*,) ...	4	0		
Coal, ...	1	0		
			7	1

Gray argillo-arenaceous shale, with *ironstone* balls in abundance and *stigmariæ ficoides* (*underclay*),	6	0
Gray rough crumbly sandstone, ...	9	0
Dark gray shale, with *ironstone* balls, ...	1	0
Gray arenaceous shale, ...	3	0
Gray sandstone, ...	3	0
Red argillaceous shale (chocolate coloured), ...	10	0
Gray sandstone, ...	1	0
Red argillaceous shale as before, ...	10	0
Gray rough sandstone, ...	3	0
Red argillaceous shale, as before, in beds of 1 to 4 feet, with *ironstone* balls, and separated by beds of gray sandstone of 1 foot, ...	20	0
Gray rough sandstone, in beds of 1 to 2 feet, alternating with beds of red or chocolate coloured shale of 1 foot, ...	15	0
Gray soft sandstone, ...	1	0
Red shale, ...	1	0
Gray rough sandstone, ...	1	6
Gray arenaceous shale, with *stigmariæ* (*underclay*),	2	0
Gray crumbly arenaceous shale, with *ironstone* balls,	6	0
Gray arenaceous shale, ...	2	0
Gray crumbly sandstone, ...	1	0
Gray argillaceous shale, ...	0	10
Gray sandstone, with *stigmariæ* and upright *calamites* (*understone*), ...	1	6
Gray argillaceous shale, with *ironstone* balls, ...	1	10
Gray rough crumbly sandstone, ...	0	10
Gray argillaceous shale, with *ironstone* balls and *stigmariæ ficoides* (*underclay*),...	10	0
9. COAL and *Carbonaceous shale*, ...	1	3
Greenish gray argillaceous shale, with *stigmariæ ficoides* (*underclay*), ...	12	0
Gray rough sandstone, with *stigmariæ* (*underclay*),...	3	0
Red argillaceous shale, with *ironstone* balls, ...	2	0
Reddish sandstone, ...	2	0
Red or chocolate coloured argillaceons shale, with *ironstone* balls, ...	5	0
Gray argillo-arenaceous shale, with *stigmariæ* (*underclay*), ...	1	6
Red or chocolate coloured and green argillaceous shale, ...	3	0
10. COAL and *Carbonaceous shale*, ... 0 2		
Carbonaceons shale, ... 0 6		
COAL, ... 0 4		
	1	0

Argillo-arenaceous shale, with *stigmariæ ficoides* (*underclay*), ...	1	0
Measures concealed, probably underclay. Here occurs Bell's Brook, ...	5	0
Red and green shale as before, ...	9	0
Gray sandstone, ...	1	0
Red argillaceous shale and gray arenaceous shale, ...	3	0
Red and green shale, as before, ...	3	0
Gray arenaceous shale, ...	2	0
Red and green shale, as before, ...	7	0
Gray sandstone, ...	3	0
Red and green shale, as before, ...	3	0
Gray sandstone, ...	1	0
Red or chocolate coloured argillaceous shale, ...	2	0
Gray sandstone, ...	1	0
Red and green shale, as before, ...	5	0
Red or chocolate coloured argillaceous shale, ...	1	0
Gray arenaceous shale, ...	14	0
Gray sandstone, rough and uneven, ...	12	0
(From the top of the succeeding bed spring several upright *calamites*, 3 of them in the distance of 2 feet, and 8 more—the whole 11, in the distance of 20 feet.)		
Gray crumbly argillaceous shale, like *underclay*, but no *stigmariæ* visible, ...	2	0
Greenish sandstone, ...	0	6
Red or chocolate coloured argillaceous shale, ...	3	0
11. COAL and *carbonaceous shale*, ...	0	8
Gray argillaceous shale, with *stigmariæ ficoides* (*underclay*), ...	7	0
Gray rough sandstone and arenaceous shale, in alternate layers, ...	12	0
Greenish gray sandstone, ...	1	0
Gray argillaceous shale, ...	1	0
Gray arenaceous shale, ...	6	0
Strong gray arenaceous shale and rough sandstone,	4	0
Gray argillaceous shale, ...	6	0
12. COAL and *carbonaceous shale*, ...	1	0
Gray argillaceous shale, with *stigmariæ ficoides* and *ironstone* balls (*underclay*), ...	2	0
Gray argillaceous sandstone, with *stigmariæ* (*understone*), ...	3	0
Dark gray argillaceous shale, ...	8	0
13. COAL and *carbonaceous shale*, ...	0	6

Gray argillaceous shale, with *stigmariæ* and *ironstone* balls (*underclay*), ...	2	0
Gray argillaceous sandstone, with *stigmariæ* (*underclay*), ...	2	0
Red and green shale, as before, ...	7	0
Gray argillaceous sandstone, with *stigmariæ* (*understone*), ...	1	0
Red and green argillaceous shale, with *stigmariæ ficoides* (*underclay*), ...	7	0
Gray sandstone and shale, ...	1	0
Red or chocolate coloured and green argillaceous shale, ...	3	0
Gray soft shaly sandstone, ...	1	0
Measures concealed, but supposed to be soft, ...	7	0
Greenish gray soft sandstone, ...	4	0
Measures concealed, but supposed to be soft, ...	2	0
Gray sandstone, ...	4	0
Measures concealed, but supposed to be soft, ...	3	0
Reddish green sandstone, ...	3	0
Gray sandstone and shale, ...	1	0
Red argillaceous shale, ...	1	0
Green arenaceous shale, ...	1	0
Gray sandstone, ...	1	0
Gray argillaceous shale, ...	6	0
Green and red shale, ...	3	0
Gray sandstone, with a bed of argillaceous shale, ...	2	0
Greenish gray argillaceous shale, with *ironstone* balls,	17	0
Reddish green sandstone, ...	1	0
(In this are upright *calamites*—3 of them in the space of 1 foot.)		
Gray argillaceous shale, ...	2	0
Gray rough sandstone, ...	1	0
Gray argillaceous shale, ...	2	0
Greenish gray or drab coloured sandstone; grindstones have been quarried from this, but they are too hard for the best quality. This constitutes Coal Mine Point, ...	30	0
Gray argillaceous shale, with balls of *ironstone*, ...	3	0
Greenish gray sandstone, ...	1	0
Gray argillaceous shale, with balls of *ironstone*, ...	8	0

14. Coal, ...	0	3		
Carbonaceous shale, ...	0	2		
Coal, ...	0	3		
			0	8

Gray argillo-arenaceous shale, with *stigmariæ ficoides* (*underclay*), ...			6	0		
Carbonaceous shale, ...	0	4				
Gray argillo-arenaceous shale, with *stigmariæ* (*underclay*),	1	0				
Carbonaceous shale, ...	0	8				
COAL, ...	0	2				
			2	2		
					8	10
Gray argillo-arenaceous shale, with *stigmariæ ficoides* (*underclay*,)					2	6
Greenish gray sandstone, ...					2	0
Gray argillo-arenaceous shale, with bands of sandstone, ...					2	0
(From the succeeding bed there spring up erect *calamites*, penetrating the above bed 2 feet; 2 of them are within 2 feet of one another, and there are 7 more in the space of 8 feet.)						
15. *Carbonaceous shale*, ...			1	0		
COAL, ...			0	4		
					1	4
Gray crumbly sandstone and shale, with *stigmariæ* (*underclay*), ...					2	0
Gray crumbly sandstone, very like *underclay*, but no *stigmariæ* visible, ...					12	0
Gray argillo-arenaceous shale, with *stigmariæ* (*underclay*), ...					5	0
Greenish gray sandstone, ...					2	0
Dark red shale, with *ironstone* balls, ...					4	0
Greenish gray sandstone, ...					5	0
Dark red shale, ...					1	0
Greenish gray sandstone, ...					3	0
Dark red or chocolate coloured argillaceous shale, ...					6	0
Greenish gray sandstone, and red or chocolate coloured shale of an argillo-arenaceous character, ...					12	0
Gray argillo-arenaceous shale, with *stigmariæ*, and some beds of sandstone with *stigmariæ* leaves crossing them (*underclay*), ...					12	0
Gray crumbly sandstone, with beds of argillaceous shale, and *ironstone* balls, very like *underclay*, but no *stigmariæ* visible, ...					25	0
16. COAL and *carbonaceous shale*, ...					0	6
Gray argillo-arenaceous shale, with *stigmariæ* (*underclay*,)					3	0
Greenish gray sandstone, ...					10	0
Gray argillaceous shale, ...					1	0

Gray soft sandstone, ...			1	0
Gray argillaceous shale, ...			0	6
Gray argillo-arenaceous shale, with *stigmariæ* (*underclay*,)			4	0
Gray argillaceous shale, ...			6	0
17. Coal and *carbonaceous shale*, ...			0	3
Gray argillo-arenaceous shale, with *stigmariæ* (*underclay*,)			2	0
Gray argillaceous sandstone, ...			18	0
Gray argillaceous shale, ...			11	0
18. Coal, ...			0	8
Gray argillo-arenaceous shale, with *stigmariæ* (*underclay*,)			1	6
Gray soft flaggy sandstone, ...			3	6
Gray argillaceous shale, with *stigmariæ* (*underclay*,)			3	0
Gray arenaceous shale, with *stigmariæ* (*underclay*,)			3	0
Gray argillo-arenaceous shale, with *stigmariæ* (*underclay*,)			4	0
Gray soft flaggy sandstone, with *stigmariæ* at the top (*understone*,)			3	0
Fine gray argillo-arenaceous shale, ...			4	0
Greenish gray sandstone, ...			1	0
Dark gray argillaceous shale, ...			6	0
19. *Carbonaceous shale*, ...	4	0		
Bituminous limestone, with *shells* and *fish scales*, ...	2	6		
Coal, ...	0	1		
			6	7
Gray argillo-arenaceous shale, with *stigmariæ* (*underclay*,)			2	6
Greenish gray sandstone, ...			6	0
Gray argillaceous shale, ...			12	0
20. *Black bituminous shale*, ...	1	0		
Black bituminous limestone, with *shells*,	1	6		
Coal, ...	0	6		
			3	0
Gray argillo-arenaceous shale, with *stigmariæ ficoides* (*underclay*,)			2	6
Greenish gray sandstone, ...			4	0
Gray argillaceous shale, ...			1	6
(From the top of the succeeding bed springs an upright *sigillaria* 10 inches in diameter; 2 feet 6 inches of it are visible.)				
21. Coal and *carbonaceous shale*, ...	0	3		
Gray argillaceous shale, with *stigmariæ* (*underclay*), ...	1	6		

Gray argillaceous sandstone, with *stigmariæ* (*underclay,*)	7	0		
Gray argillaceous shale, ...	4	0		
Coal, ...	0	8		
			13	5
Gray argillaceous shale, with *stigmariæ* (*underclay,*)			2	0
Gray argillaceous sandstone, with *stigmariæ* (*underclay,*)			3	0
Gray argillaceous shale, ...			9	0
Greenish gray crumbly sandstone, ...			1	0
Gray argillaceous shale, ...			5	0
22. Coal and *carbonaceous shale,*			0	2
Gray argillaceous shale, with *stigmariæ* (*underclay,*)			1	0
Greenish gray argillaceous sandstone, with *stigmariæ* (*underclay,*)			2	0
Greenish gray sandstone, ...			3	0

(From the succeeding bed springs an upright *sigillaria* 4 inches in diameter; of it 5 feet are seen. On the beach there was a transverse slice of a *sigillaria* 1 foot 6 inches in diameter, with fragments of plants on the divisional surfaces.)

Argillaceous shale, ...			2	0
23. *Carbonaceous shale,* with some layers of argillaceous shale, ...	4	0		
Coal and *carbonaceous shale,* ...	0	4		
Bituminous limestone, with minute *shells* and *stigmariæ ficoides,* ...	0	4		
Coal and *carbonaceous shale,* ...	1	0		
			5	8
Gray argillo-arenaceous shale, with *stigmariæ* (*underclay,*)			1	0
Gray crumbly argillo-arenaceous shale, very like *underclay* in quality, but no *stigmariæ* visible, ...			5	0
Gray sandstone, ...			3	0
Gray crumbly argillo-arenaceous shale, or sandstone, with *stigmariæ,* (*underclay,*)			6	0

(From the top of the succeeding bed springs an upright *sigillaria.* Its roots spread out into the shale. It is coated with coal, and the material of the interior cast is not of uniform quality, being partly sandstone and partly shale. The shale occupies a transverse portion about 6 inches thick, and is rather less than half way up the stem, of which about 6 feet are visible, running into the underclay above. From the root of the plant, as if it had wound round or been pushed aside by the root, proceeds a *stigmaria* branch. It runs horizontally a short distance, and then turns up vertically. The leaves proceeding from the vertical portion, are not at right angles to the branch, but in part at least assume a vertical direction, and run parallel with it; those emanating from the grooved side (in ordinary cases the under part or belly of the branch) taking a downward, and those from the back an upward, course. The leaves issuing from the sides may be at right angles to the branch, and run horizontally into the bed, but being thus concealed they could not be traced. At first sight the stigmaria branch had much the appearance of being a continuation of the root of the sigillaria, but close inspection shewed that the two, although touching, were distinct. The former rested on the latter nearly one-eighth of a circle, but being then suddenly cut off, it may when entire have wound much farther round, and the carbonaceous envelopes of the two plants were clearly discernible. *See fig.* 5.)

Gray argillaceous shale, ...			10	0
24. *Bituminous limestone*, with *shells* and *cone in cone*, ...	1	0		
Coal and *carbonaceous shale*, ...	0	1		
			1	1
Gray argillo-arenaceous shale, with *stigmariæ ficoides* (*underclay*,)			2	0
Gray argillaceous shale, ...			3	0
25. Coal and *carbonaceous shale*, ...			0	8
Gray argillaceous shale, with *stigmariæ* (*underclay*,)...			2	0
Greenish gray sandstone, with *stigmariæ* leaves (*underclay*,)			6	0
Greenish gray sandstone, ...			9	0
Greenish gray sandstone and shale, ...			4	0
Gray argillaceous shale, with *ironstone* balls, ...			2	0
Greenish gray sandstone, with some beds of arenaceous shale, ...			20	0
Gray argillaceous shale, ...			2	0
Greenish gray sandstone, ...			35	0
Gray argillaceous shale, ...			10	0
Gray sandstone, ...			7	0

(From the succeeding bed springs an upright *sigillaria* 1 foot 6 inches in diameter. It penetrates through the sandstone.)

Gray argillaceous shale, ...					2	0
Greenish gray sandstone, ...					10	0
Gray argillaceous shale, ...					2	0
26. *Carbonaceous shale*, ...					0	4
Gray argillaceous shale, with *stigmariæ* (*underclay*,)					3	0
Gray crumbly sandstone, being probably argillaceous; it contains *stigmariæ* leaves (*underclay*,) ...					8	0
Gray argillaceous shale, ...					2	0
27. COAL, ...					0	3
Gray argillo-arenaceous shale, with *stigmariæ* leaves (*underclay*,)					5	0
Greenish gray sandstone, with shale dividing the beds; in the lower part is an upright *calamite* which springs from the succeeding bed, ...					4	0
Gray argillaceous and arenaceous shale, with *ironstone* balls and a few beds of sandstone, ...					14	0
Greenish gray sandstone in 3 beds divided by argillo-arenaceous shale,...					12	0
Gray argillaceous shale, ...					3	0
Gray argillaceous shale, with *ironstone* balls and one course of sandstone, ...					13	0
Greenish gray sandstone, ...					4	0
Gray argillaceous shale, with *ironstone* nodules, ...					3	0
28. *Bituminous limestone* and *carbonaceous shale* in alternate layers of 1 to 3 inches, with *plants*, *shells* and *fish scales*, ...			6	0		
COAL and *carbonaceous shale*—not much coal, ...	3	0				
COAL and *carbonaceous shale*—a good deal of coal, ...	4	0				
			7	0		
Gray argillo-arenaceous shale, with *stigmariæ* (*underclay*,)			4	0		
Carbonaceous shale, ...	1	0				
COAL, ...	0	6				
			1	6		
					18	6
Gray rough sandstone, with *stigmariæ* leaves (*underclay*,)					3	0
Greenish gray argillaceous shale, with *ironstone* balls, ...					6	0

Gray sandstone, ...					6	0
Greenish gray argillaceous shale, with nodules of *ironstone* disseminated through it, ...					7	0
Gray argillo-arenaceous shale, with *ironstone* balls and small seams of *coal*, ...					7	0
(From the succeeding bed rises an upright *sigillaria;* the roots spread on the top of it; the diameter of the plant is a foot; only 1 foot of the length is visible.)						
29. COAL and *carbonaceous shale;* the coal being a small seam on the top of the carbonaceous shale, ...			2	0		
Gray argillo-arenaceous shale, with *stigmariæ* and *ironstone* balls disseminated through it (*underclay*,)...			2	0		
COAL, ...	1	8				
Carbonaceous shale, ...	0	3				
COAL, ...	0	11				
Carbonaceous shale, ...	0	4				
COAL, ...	0	10				
			4	0		
Gray argillo-arenaceous shale, with *stigmariæ* leaves crossing the bed (*underclay*,)			8	0		
Carbonaceous shale, gray argillo-arenaceous shale, with *stigmariæ* and small seams of *coal*, ...			6	0		
COAL and *carbonaceous shale*,	0	6				
Gray argillaceous shale, ...	0	6				
COAL, ...	0	6				
			1	6		
Gray argillaceous shale (*underclay?*)			0	10		
Bituminous limestone, with *plants*, *shells* and *fish scales*, ...			0	3		
					24	7
Gray argillo-arenaceous shale, with *ironstone* nodules and *stigmariæ* leaves (*underclay*), ...					7	0
Gray arenaceous shale and sandstone; the sandstone exhibits some *stigmariæ* leaves crossing it, and in the shale are *ironstone* nodules (*underclay*), ...					20	0
(From the succeeding bed rises an upright fluted stem (*sigillaria*) 10 inches in diameter, of which 12 feet are visible; and 2 upright *calamites*.)						
Gray argillaceous shale with *ironstone* balls, ...					6	0

30. Coal, ...			0	4		
Dark gray argillaceous shale (*under-clay?*)			2	0		
Coal and *carbonaceous shale*, ...			0	2		
Coal, ...			0	3		
Carbonaceous shale, ...			0	6		
Coal, ...			0	1		
					3	4
Gray soft clay (*underclay?*)					2	0
Gray argillo-arenaceous shale and sandstone; the shale contains balls of *ironstone* at the bottom; there are *stigmariæ* leaves visible towards the top; towards the lower part of the bed of sandstone there is an upright *calamite* of 2 inches diameter, of which 18 inches are visible, ...					15	0
Gray sandstone, with impressions of prostrate *sigillariæ* underneath, ...					2	0
31. Coal and *carbonaceous shale*, ...			1	0		
Gray argillo-arenaceous shale, with *stigmariæ* (*underclay*), ...			1	0		
Gray argillaceous shale, with streaks of *coal*, ...	0	6				
Coal, ...	0	2				
			0	8		
					2	8
Gray argillaceous shale, with *ironstone* balls and *stigmariæ* leaves (*underclay*), ...			9	0		
Bituminous limestone, with *stigmariæ*, *shells* and *fish scales*, ...			0	2		
					9	2
Gray sandstone, ...					1	0
Gray argillaceous shale, with *ironstone* balls, ...					7	0
Gray sandstone, ...					2	0
Gray argillaceous shale, with *ironstone* balls, ...					4	0
Gray sandstone, ...					6	6
Gray argillaceous shale, ...					4	0
32. Coal, ...			0	8		
Carbonaceous shale, ...			0	1		
Coal, ...			0	8		
Carbonaceous shale, ...			0	1		
Coal, ...			0	4		
Carbonaceous shale, ...			0	3		
Coal, ...			0	1		
Carbonaceous shale, ...			0	1		
Coal, ...			0	1		
					2	4

Gray argillo-arenaceous shale, with *stigmariæ* (*underclay*,)			4	0
Greenish gray argillo-arenaceous sandstone, with *stigmariæ ficoides* (*underclay*), ...			1	0
Greenish gray argillo-arenaceous shale, with *stigmariæ* (*underclay*), ...			4	0
Greenish gray sandstone, with *stigmariæ* (*underclay*),			4	0
Greenish argillaceous shale, ...			6	0
Reddish sandstone, with dividing bands of red shale of 3 inches to 1 foot, ...			20	0
Reddish sandstone. The bed is of irregular thickness, the bottom swelling out suddenly in many places. The bed holds carbonized plants, ...			2	0

(From the top of the succeeding bed there springs an upright *sigillaria*. Two feet of the length is seen, but it is cut clean off at the top and at the bottom by the measures, which pass both without disturbance. *See fig.* 6.)

Red argillaceous shale, ...			5	0
Reddish arenaceous shale, with thin bands of sandstone, ...			3	0
Reddish and greenish sandstone, ...			4	0
Red and green arenaceous shale with *ironstone* balls, and some bands of sandstone, ...			25	0
Red and green sandstone, ...			12	0
Reddish and greenish argillaceous shale, loaded with *ironstone* balls, and having bands of sandstone,			10	0
Reddish and greenish sandstone, ...			10	0
Red and green argillaceous shale, loaded with *ironstone* nodules, ...			10	0
Red and green sandstone, ...			5	0
Greenish gray argillaceous shale, ...			15	0
Greenish gray sandstone, ...			2	0

(From the succeeding bed there starts an upright *sigillaria* 4 inches in diameter; it is planted 2 feet in it, and penetrates the sandstone above, being 4 feet in length altogether.)

Greenish gray argillaceous shale, ...			6	0
33. *Carbonaceous shale*, ...	1	0		
COAL, ...	0	1		
			1	1
Greenish gray argillaceous shale, with *stigmariæ* leaves (*underclay*), ...			4	0

Red and gray sandstone, with arenaceous shale, ...	7	0
Red argillaceous shale, with a band of sandstone, ...	4	0
Red sandstone, with bands of red arenaceous shale,	10	0
Red and green argillaceous shale, ...	20	0
Reddish sandstone, ...	1	0
Red and green argillaceous shale, ...	3	0
Reddish sandstone in uneven layers, with reddish bands of arenaceous shale, ...	18	0
Red and green argillaceous shale, ...	18	0
Reddish sandstone, ...	2	0
Red arenaceous shale,...	3	0
Red and green argillaceous shale, ...	4	0
Reddish sandstone, ...	1	0
Red and green arenaceous shale, ...	4	0
Reddish sandstone, ...	1	0
Red and green arenaceous shale, ...	7	0
Reddish sandstone, ...	1	0
Red argillaceous shale, ...	3	0
Red and green argillaceous shale, with bands of sandstone, ...	25	0
Red sandstone, ...	1	0
Red and green shale, with bands of sandstone, ...	12	0
Red and green sandstone, ...	4	0
Red and green argillaceous shale, with bands of reddish sandstone, ...	15	0
Red and green sandstone and shale, ...	3	0
Red or chocolate coloured shale, with large balls of red argillaceous *ironstone*, ...	12	0
Red and green sandstone, separated by bands of red and green argillaceous shale of about 1 foot each,	30	0
Red or chocolate coloured argillaceous shale, with some balls of red argillaceous *ironstone*, ...	12	0
Reddish sandstone, ...	4	0
Red argillaceous shale, ...	1	6
Red sandstone, ...	2	0
Red argillaceous shale, ...	2	0
Reddish sandstone, ...	1	0
Red argillaceous shale, with a band of sandstone, ...	12	0
Gray sandstone, with *ironstone* nodules and *stigmariæ* leaves (*underclay*), ...	10	0

(From the succeeding bed arise 2 upright *sigillariæ*. The roots of one of them spread out just on the top of the bed, and 2 feet of the plant are visible. The roots of the other spread out likewise, but they sink deeper into the shale by 2 feet, and the plant penetrates farther into the superincumbent sandstone. *See fig.* 7.)

Red and dark gray variegated shale, with small balls of *ironstone* and *stigmariæ* (*underclay*), ...			28	0
Gray sandstone, ...			2	0
Greenish shale, with *ironstone* balls and *stigmariæ ficoides* (*underclay*), ...			4	0
34. *Carbonaceous shale and coal,* ...	0	2		
Greenish gray argillaceous shale, with *ironstone* balls and *stigmariæ* branches and leaves; one of the branches, replaced by *ironstone*, is 8 feet long,	4	0		
Carbonaceous shale, ...	0	2		
			4	4
Gray argillo-arenaceons shale, with black streaks and *stigmariæ* (*underclay*), ...			3	0
Gray sandstone, with *stigmariæ* (*understone*), ...			0	10
Red and green argillaceous shale, with *stigmariæ* (*underclay*), ...			4	0
Gray crumbly sandstone, ...			3	0
Gray argillo-arenaceous shale, with *stigmariæ* (*underclay*), ...			3	0
35. *Carbonaceous shale,*			0	3
Red and green argillaceous shale, with *stigmariæ* leaves at the top (*underclay*), ...			6	0
Argillaceous *ironstone*, in a bed, ...			0	6
Red and green argillaceous shale, ...			1	0
Gray sandstone, with *stigmariæ* leaves (*underclay*),			1	0
Greenish gray argillaceous shale, with dark bands; *argillaceous iron ore* nodules abound, and towards the top *stigmariæ* branches and leaves are visible (*underclay*), ...			28	0
Greenish gray crumbly sandstone, ...			8	0
Gray argillaceous shale, with *ironstone* balls. In this there is visible an upright stem (*sigillaria*), 1 foot in diameter; the top only is visible, and it is at the top of the bed, ...			12	0
36. *Black bituminous limestone*, with branches and leaves of *stigmariæ* well marked, and very minute *shells*, ...	1	3		
Carbonaceous shale and streaks of *coal*,	0	3		
			1	6
Red argillaceous shale, with *ironstone* (*underclay ?*)			4	0
Gray argillo-arenaceous shale, with *stigmariæ* and *ironstone* balls (*underclay*), ...			6	0

Gray argillaceous shale, with *ironstone* balls, ...			5	0
Gray arenaceous shale, ...			2	0
Gray argillaceous shale, ...			5	0
37. *Dark bituminous limestone*, with *shells*, replaced by pyrites, ...	0	3		
COAL and *carbonaceous shale*, ...	0	10		
Gray argillaceous shale, with *stigmariæ* (*underclay*), ...	1	6		
COAL, ...	0	6		
Gray argillaceous shale, with *stigmariæ* (*underclay*), ...	1	0		
Dark bituminous limestone, with *stigmariæ* branches and leaves, and also *shells*, ...	0	3		
Gray argillaceous shale, ...	0	3		
COAL, ...	1	0		
			5	7
Gray argillaceous shale of a crumbly character, with *ironstone* balls and *stigmariæ* (*underclay*), ...			6	0
Greenish gray rough sandstone, ...			4	0
Dark gray argillaceous shale, with *ironstone* balls, ...			7	0
Greenish gray sandstone, ...			1	0
Red argillaceous shale, ...			4	0
Greenish gray sandstone, ...			2	0
Red argillaceous shale, with *ironstone* balls, ...			8	0
Red and green sandstone, with bands of red argillaceous shale under 8 inches thick, ...			6	0
Red argillaceous shale, with bands of sandstone under 8 inches thick, ...			20	0
Reddish sandstone, hard, ...			1	0
Red argillaceous shale, with balls of *ironstone*, ...			4	0
Reddish sandstone, hard, ...			0	3
Green argillaceous shale, ...			0	6
Greenish gray sandstone, with carbonized fragments of drift plants, ...			1	0
Dark gray argillaceous shale, with a red band near the top, ...			10	0
38. COAL, ...	0	1		
Black bituminous limestone, with *shells* and *plants*, *stigmariæ* branches and leaves, ...	0	6		
COAL, ...	0	2		
			0	9
Red argillaceous shale, studded with *ironstone* balls: *stigmariæ* not visible (*underclay?*)... ...			10	0

feet, and the plant penetrates farther into the superincumbent sandstone. *See fig.* 7.)

Red and dark gray variegated shale, with small balls of *ironstone* and *stigmariæ* (*underclay*), ...			28	0
Gray sandstone, ...			2	0
Greenish shale, with *ironstone* balls and *stigmariæ ficoides* (*underclay*), ...			4	0
34. *Carbonaceous shale and coal*, ...	0	2		
Greenish gray argillaceous shale, with *ironstone* balls and *stigmariæ* branches and leaves; one of the branches, replaced by *ironstone*, is 8 feet long,	1	0		
Carbonaceous shale, ...	0	2		
			4	4
Gray argillo-arenaceons shale, with black streaks and *stigmariæ* (*underclay*), ...			3	0
Gray sandstone, with *stigmariæ* (*understone*), ...			0	10
Red and green argillaceous shale, with *stigmariæ* (*underclay*), ...			4	0
Gray crumbly sandstone, ...			3	0
Gray argillo-arenaceous shale, with *stigmariæ* (*underclay*), ...			3	0
35. *Carbonaceous shale*, ...			0	3
Red and green argillaceous shale, with *stigmariæ* leaves at the top (*underclay*), ...			6	0
Argillaceous *ironstone*, in a bed, ...			0	6
Red and green argillaceous shale, ...			1	0
Gray sandstone, with *stigmariæ* leaves (*underclay*),			1	0
Greenish gray argillaceous shale, with dark bands; *argillaceous iron ore* nodules abound, and towards the top *stigmariæ* branches and leaves are visible (*underclay*), ...			28	0
Greenish gray crumbly sandstone, ...			8	0
Gray argillaceous shale, with *ironstone* balls. In this there is visible an upright stem (*sigillaria*), 1 foot in diameter; the top only is visible, and it is at the top of the bed, ...			12	0
36. *Black bituminous limestone*, with branches and leaves of *stigmariæ* well marked, and very minute *shells*, ...	1	3		
Carbonaceous shale and streaks of *coal*,	0	3		
			1	6
Red argillaceous shale, with *ironstone* (*underclay?*)			4	0
Gray argillo-arenaceous shale, with *stigmariæ* and *ironstone* balls (*underclay*), ...			6	0

Gray argillaceous shale, with *ironstone* balls, ...			5	0
Gray arenaceous shale, ...			2	0
Gray argillaceous shale, ...			5	0
37. *Dark bituminous limestone*, with *shells*, replaced by pyrites, ...	0	3		
COAL and *carbonaceous shale*, ...	0	10		
Gray argillaceous shale, with *stigmariæ* (*underclay*), ...	1	6		
COAL, ...	0	6		
Gray argillaceous shale, with *stigmariæ* (*underclay*), ...	1	0		
Dark bituminous limestone, with *stigmariæ* branches and leaves, and also *shells*, ...	0	3		
Gray argillaceous shale, ...	0	3		
COAL, ...	1	0		
	——		5	7
Gray argillaceous shale of a crumbly character, with *ironstone* balls and *stigmariæ* (*underclay*), ...			6	0
Greenish gray rough sandstone, ...			4	0
Dark gray argillaceous shale, with *ironstone* balls, ...			7	0
Greenish gray sandstone, ...			1	0
Red argillaceous shale, ...			4	0
Greenish gray sandstone, ...			2	0
Red argillaceous shale, with *ironstone* balls, ...			8	0
Red and green sandstone, with bands of red argillaceous shale under 8 inches thick, ...			6	0
Red argillaceous shale, with bands of sandstone under 8 inches thick, ...			20	0
Reddish sandstone, hard, ...			1	0
Red argillaceous shale, with balls of *ironstone*, ...			4	0
Reddish sandstone, hard, ...			0	3
Green argillaceous shale, ...			0	6
Greenish gray sandstone, with carbonized fragments of drift plants, ...			1	0
Dark gray argillaceous shale, with a red band near the top, ...			10	0
38. COAL, ...	0	1		
Black bituminous limestone, with *shells* and *plants*, *stigmariæ* branches and leaves, ...	0	6		
COAL, ...	0	2		
	——		0	9
Red argillaceous shale, studded with *ironstone* balls; *stigmariæ* not visible (*underclay?*)... ...			10	0

Reddish sandstone, ...			2	0
Green arenaceous shale, with red argillaceous bands,			15	0
Red and green sandstone, ...			2	0
Red argillaceous shale, ...			1	0
Green arenaceous shale, ...			1	0
Red argillaceous shale, ...			3	0
Green arenaceous shale, ...			1	0
Red argillaceous shale, ...			5	0
Gray bituminous limestone, with *minute shells*, ...			0	6
Red argillaceous shale, with *ironstone* balls, ...			11	0
Green and dark gray argillaceous shale, with *ironstone* balls, ...			14	0
Red and green argillaceous shale, with *ironstone* balls; in this are some dark bands of shale, ...			25	0
Greenish gray sandstone, with a confused mass of carbonized drift plants, ...			10	0
Greenish gray sandstone, ...			2	6
Red argillaceous shale, with a band of sandstone, ...			2	0
Gray and black shale, ...			3	0
Carbonaceous shale, ...			1	0
Red and green argillaceous shale, studded with *ironstone* balls; no *stigmariæ* visible (*underclay?*)			15	0
39. Coal, ...	0	0½		
Gray argillaceous shale, with *stigmariæ*,	0	6		
Dark gray limestone, with *stigmariæ* branches and leaves, and minute *shells*, ...	0	4		
			0	10½
Red and green argillaceous shale, with *stigmariæ* leaves (*underclay*), ...			1	6
Red and green sandstone, ...			1	0
Red argillaceous shale, with some green and gray bands; the whole containing thin bands of sandstone, ...			18	0
Greenish gray sandstone, ...			8	0
Dark red and green argillaceous shale, studded with *ironstone* balls, ...			15	0
Gray hard argillaceous sandstone, ...			1	0
Dark gray argillaceous shale, with *ironstone* balls in considerable number, with some red argillaceous beds, ...			20	0
40. *Black bituminous limestone*, with *shells*,	0	1½		
Carbonaceous shale, ...	0	0½		
Black bituminous limestone, with *shells*,	0	1		
Gray argillaceous shale, ...	0	2		

	Black bituminous limestone, with *shells*,	0	2		
	Gray argillaceous shale, with *ironstone* balls (*underclay* ?)	1	0		
	Coal, ...	0	1		
	Carbonaceons shale, with thin seams of *coal*, ...	0	3		
	Gray argillo-arenaceous shale, with *stigmariæ ficoides* (*underclay*,) ...	1	0		
	Black bituminous limestone, with *shells* and *stigmariæ*, ...	0	6		
	Carbonaceous shale and thin laminæ of *coal*, ...	0	2		
				3	7
	Green argillaceous shale, with many coarse nodules of clay *ironstone*, all small, and impressions of *stigmariæ* leaves crossing the bed (*underclay*),			5	0
41.	*Black calcareo-bituminous shale*, with *shells*, ...	0	8		
	Black calcareo-bituminous shale, more calcareous, with *shells*, ...	0	2		
	Black calcareo-bituminous shale, less calcareous, with *shells*, ...	1	0		
	Carbonaceous shale, with laminæ of *coal*,	1	6		
	Gray argillaceous shale, with *stigmariæ* (*underclay*,)	3	0		
	Carbonaceous shale, ...	0	1		
				6	5
	Gray argillaceous shale, with *stigmariæ* (*underclay*,)			2	0
	Greenish gray argillo-arenaceous shale, in alternate hard and soft layers, with *stigmariæ* leaves (*underclay*), ...			2	6
	Greenish gray sandstone, ...			2	0
	Dark gray argillaceous shale, studded with *ironstone* nodules, ...			4	0
42.	*Carbonaceous shale*, ...	0	7		
	Black bituminous limestone, with *shells* replaced by pyrites, ...	0	2		
	Coal, ...	0	3		
	Carbonaceous shale, ...	1	0		
	Coal, ...	1	0		
	Gray argillaceous shale, with *stigmariæ* (*underclay*), ...	1	0		
	Coal, ...	0	2		
				4	2

Dark gray argillaceous shale, with *stigmariæ* (*underclay*),			5	0
Red argillaceous shale, with some green bands, and studded with *ironstone* balls,			25	0
Reddish sandstone,			1	0
Red argillaceous shale, with *stigmariæ* (*underclay*,)			4	0
43. *Carbonaceous shale*,			0	1
Red shale, with *stigmariæ* (*underclay*),	0	3		
Gray sandstone, very hard, (*ganister*, as the Lancashire miners call it,) with *stigmariæ*,	0	8		
Red argillaceous shale, with *stigmariæ* (*underclay*,)	3	0		
Gray sandstone, very hard, with *stigmariæ* (*ganister* or *understone*),	0	10		
Gray argillaceous shale, with *stigmariæ* (*underclay*),	0	10		
Gray sandstone, very hard, with *stigmariæ* (*understone*),	1	0		
Gray sandstone, very hard, with *stigmariæ* leaves running across the bed, *ganister* or *understone*,)	2	0		
			8	7
Red argillaceous shale, green at the bottom,			15	0
Gray arenaceous and argillaceous shale, with greenish gray sandstone containing prostrate carbonized plants,			12	0
(Into this bed penetrate several upright *calamites* which start from the one subjacent, on the top of which one of 3 inches in diameter is seen to spread its roots, and 21 more are visible along the face of the bank in the space of 20 yards; their diameters vary from ½ inch to 4 inches.)				
Dark gray argillaceous shale,			2	0
Gray sandstone,			1	0
Dark gray argillaceous shale,			15	0
Gray sandstone,			0	4
Dark gray argillaceous shale, with *ironstone* balls and bands of sandstone,			4	0
Dark gray argillaceous shale, with *ironstone* balls,			5	0
44. *Carbonaceous shale*,	1	6		
Dark gray argillaceous shale,	2	0		
Carbonaceous shale, with *ironstone* balls,	0	4		
Dark gray argillaceous shale, with *ironstone* balls,	6	0		

Blach bituminous limestone, with *shells*,	0	1½		
Dark green argillaceous shale, ...	0	1½		
COAL, ...	0	0½		
Black bituminous limestone, with *plants* and minute *shells*, ...	0	0½		
COAL, ...	0	5		
Black bituminous limestone, with *stigmariæ* and other plants, ...	0	2		
COAL, ...	0	1		
Black bituminous limestone, with *stigmariæ* branches and leaves, and fragments of other plants, ...	0	2		
COAL, ...	0	0½		
			11	0½
Gray crumbly argillo-arenaceous shale, with indistinct *stigmariæ* leaves (*underclay*,)			3	
Red and green crumbly argillaceous shale (*underclay*,)			10	
Red and green sandstone, ...			5	0
Red or chocolate coloured argillaceous shale, ...			1	6
Reddish sandstone, ...			1	0
Red or chocolate coloured argillaceous shale, ...			1	0
Greenish gray sandstone, ...			9	0
Red argillaceous shale, with thin green beds and some patches of sandstone, ...			40	0
Red shale, with a considerable number of small beds of sandstone, ...			6	0
Greenish gray sandstone, with upright *calamites* about 2 inches in diameter; some of them are traceable for 4 feet in the upper part of the bed; 6 of them are visible; the top of the bed is reddish in colour, ...			10	0
Red argillaceous shale, studded with *ironstone* balls,			10	0
Gray hard argillo-arenaceous shale, with *stigmariæ* (*underclay*), ...			1	0
Red argillaceous shale, ...			1	0
45. *Carbonaceous shale*, ...	0	10		
COALY matter, ...	0	0½		
Gray hard argillo-arenaceous stone, with *stigmariæ* (*underclay*), ...	2	0		
COALY matter, ...	0	0½		
Green argillaceous shale, with *stigmariæ* (*underclay*), ...	7	0		
COAL, ...	0	3		
			10	2

Greenish gray arenaceous shale, with stigmaria underclay), ...	3	0
Red arenaceous and argillaceous shale, with sandstone, ...	2	0
Red sandstone of a soft quality, ...	0	6
	2539	1

RECAPITULATION.

COAL in 45 seams, ...	37	9½		
Carbonaceous shale associated with the above coal seams, and in one instance without coal, ...	36	4		
Gray argillaceous shale interstratified with the coal seams in 8 cases, in two of which the shale is 1 foot and upwards thick without exhibiting any remains of stigmariæ, ...	4	4½		
Black and gray bituminous limestone touching the coal and carbonaceous shale, often interstratified and containing the remains of fishes, shells, and occasionally stigmariæ. In one instance the limestone has no coal with it, in 16 cases it is associated with the coal seams, ...	23	3		
			101	9

Underclay or understone, being beds of various material, immediately subjacent to the seams of coal and carbonaceous shale and bituminous limestone, and invariably penetrated by the recumbent branches or radiating leaves of the stigmariæ ficoides. Every one of the seams of coal and carbonaceous shale rests upon a stigmaria bed with the exception of one instance, where 4 feet of gray argillaceous shale, destitute of the plant, is interposed between the stigmariæ bed and the coal, and one instance where the stigmariæ are doubtful. There are 12 instances of stigmariæ beds without superincumbent coal. The material constituting the stigmariæ beds is as follows:

Ganister, a hard silicious stone, ...			4	6		
Sandstone—						
Gray and crumbly, sometimes a doubtful fireclay,	72	10				
Greenish gray, ...	4	0				
			76	10		
Arenaceous shale, often fit for fireclay—						
Gray, ...	189	0				
Greenish gray, ...	25	6				
Red, ...	6	0				
			220	6		
Argillaceous shale, sometimes fit for fireclay—						
Gray, ...	99	4				
Greenish gray, ...	28	0				
Green, ...	12	10				
Red and green, ...	45	0				
Red, ...	17	3				
			202	5		
					504	3

Sandstone—		
Gray in colour, and much of it of a crumbly nature, resembling the quality in which the remains of stigmariæ are found, ...	259	2
Greenish, ...	4	6
Greenish gray or drab coloured, some of it fit for grindstones, and patches of it containing carbonized drift plants, ...	232	6
Red and green, less durable in quality than the drab coloured stone, ...	69	0

Reddish, similar to the preceding in durability, ...			67	3				
Red or chocolate coloured, easily yielding to the influence of weather, ...			15	6				
					647	11		
Shale—Arenaceous—								
Gray, ...	91	0						
Gray, with ironstone balls, ...	13	0						
			104	0				
Greenish gray, ...			5	0				
Green, ...			18	6				
Reddish, ...			15	8				
Red and green, ...	42	0						
Red and green, with ironstone balls, ...	4	0						
			46	0				
					189	2		
Shale—Argillaceous—								
Gray, ...	224	8						
Gray, with ironstone balls, ...	199	4						
			424	0				
Greenish gray, ...	32	0						
Greenish gray, with ironstone balls, ...	17	0						
			49	0				
Green, ...			38	6				
Red and green, ...	153	6						
Red and green, with ironstone balls, ...	118	6						
			272	0				
Red or chocolate coloured, ...	230	6						
Red or chocolate coloured, with ironstone balls, ...	82	0						
			312	6				
					1096	0		
							2539	1

(Among the organic remains visible, are to be enumerated 15 upright sigillariæ and 56 upright calamites.)

5.

Red argillaceous shale, with *ironstone* balls, ...	6	0
Red arenaceous shale, ...	2	0
Red argillaceous shale, with beds of arenaceous shale,	16	0
Red sandstone, ...	1	0
Red argillaceous shale, ...	22	0
Red sandstone, ...	1	0
Red argillaceous shale, ...	7	0
Red argillaceous shale, with a bed of sandstone, ...	38	0
Red sandstone, ...	1	0
Red argillaceous shale, with a bed of red sandstone,	50	0
Measures concealed, but supposed to be red shale and sandstone, ...	19	0
Red sandstone, ...	1	0
Measures concealed, (red shale and sandstone?) ...	33	0
Greenish gray soft sandstone with fragments of plants carbonized, ...	3	0
Measures concealed, ...	32	0
Measures concealed, (red shale and sandstone?) a bed of sandstone at the top, ...	39	0
Greenish gray sandstone, ...	3	0
Measures concealed, (red shale and sandstone?) ...	19	0
Measures concealed, (red shale and sandstone?) a bed of red sandstone at the top, ...	50	0
Red sandstone, ...	30	0
Measures concealed, (red shale?)	3	0
Red sandstone, ...	1	0
Measures concealed (red shale and sandstone?) ...	40	0
Red shale, with some red sandstone, ...	33	0
Measures concealed, (red shale and sandstone,) ...	30	0
Reddish gray sandstone, ...	5	0
Measures concealed, ...	3	0
Red and gray sandstone of a soft quality, ...	32	0
Red arenaceous shale and sandstone, ...	6	0
Reddish gray sandstone of a soft quality, ...	6	0
Red argillaceous and arenaceous shale, ...	20	0
Red sandstone, ...	2	0
Red argillaceous shale, ...	25	0
Red sandstone, ...	2	0
Red argillaceous and arenaceous shale, ...	12	0
Red sandstone and shale, ...	8	0
Red shale and sandstone, ...	54	0
Measures concealed, (red shale?)	12	0
Measures concealed, (red sandstone and shale?) ...	3	0
Measures concealed, (red shale?)	28	0

Red shale and sandstone, ...	11	0
Red sandstone, ...	2	0
Measures concealed, but supposed to be red shale, ...	6	0
Measures concealed, but supposed to be red sandstone, ...	12	0
Measures concealed, but supposed to be red shale, ...	138	0
Red arenaceous shale, with some beds of red sandstone, ...	12	0
Red arenaceous shale with some beds of red sandstone, ...	43	0
Red sandstone, ...	17	0
Red arenaceous shale, ...	14	0
Measures concealed, ...	30	0
Red sandstone, ...	6	0
Measures concealed, but supposed to be red shale and sandstone, ...	6	0
Reddish gray sandstone, ...	9	0
Measures concealed, but supposed to be red shale and sandstone, ...	5	0
Red sandstone, ...	2	0
Measures concealed, but supposed to be red sandstone, ...	44	0
Red shale and sandstone, ...	12	0
Measures concealed, but supposed to be red shale and sandstone, ...	33	0
Red argillaceous and arenaceous shale with some beds of red sandstone, ...	132	0
Red sandstone, ...	3	0
Red arenaceous shale and sandstone, ...	17	0
Greenish gray sandstone, with patches of concretionary limestone, ...	13	0
Red argillaceous and arenaceous shale, ...	51	0
Reddish sandstone, ...	17	0
Measures concealed, ...	37	0
Reddish green sandstone, ...	24	0
Measures concealed, ...	17	0
Reddish gray sandstone, ...	18	0
Measures concealed, ...	19	0
Reddish sandstone, ...	5	0
Measures concealed, probably red shale, ...	73	0
Reddish gray sandstone, soft, with fragments of plants carbonized, ...	22	0
Measures concealed, but supposed to be red shale, ...	37	0
Red and green sandstone, with probably some patches of concretionary limestone, ...	37	0

Red argillaceous and arenaceous shale, with bands of sandstone, ...	38	0
Red sandstone, ...	2	0
Red argillaceous and arenaceous shale, with bands of sandstone, ...	18	0
Red sandstone, ...	3	0
Red argillaceous shale, ...	1	0
Greenish gray sandstone, ...	9	0
Green argillaceous shale, ...	2	0
Greenish gray sandstone, ...	5	0
Red argillaceous and arenaceous shale, with some beds of red sandstone, ...	50	0
Greenish gray sandstone, ...	7	0
Greenish gray sandstone, with concretions of limestone giving it much the appearance of a conglomerate,	1	0
Red argillaceous shale, ...	1	0
Red and green sandstone, ...	6	0
Green shale, ...	2	0
Greenish gray sandstone, ...	1	0
Greenish gray sandstone, with many calcareous concretions, giving it much the appearance of a conglomerate, ...	6	0
Red arenaceous and argillaceous shale, with some beds of sandstone, ...	17	0
Red argillaceous shale and sandstone, ...	16	0
Red arenaceous and argillaceous shale, with some sandstone, ...	8	0
Red argillaceous shale, ...	6	0
Red arenaceous shale, with some bands of sandstone,	6	0
Red sandstone, ...	12	0
Red argillaceous shale, ...	1	0
Red sandstone, ...	1	0
Red argillaceous and arenaceous shale, with a two feet bed of sandstone, ...	29	0
Red sandstone, thinning off and replaced by red shale,	5	0
Red argillaceous shale, ...	5	0
Red sandstone, ...	2	0
Red argillaceous shale, ...	3	0
Red arenaceous shale, ...	1	0
Red argillaceous shale, ...	3	0
Red arenaceous shale and sandstone, ...	3	0
Red argillaceous shale, ...	22	0
Reddish sandstone, ...	7	0
Reddish sandstone with a one foot bed, having cal-		

careous concretionary nodules, and resembling a conglomerate, with carbonized plants on the top, ...	16	0
Red argillaceous and arenaceous shale, ...	20	0
Red sandstone, ...	8	0
Red arenaceous shale and argillaceous shale, ...	12	0
Red sandstone and shale, half of each, ...	12	0
Red argillaceous shale, ...	5	0
Red arenaceous shale, ...	1	0
Red sandstone, ...	5	0
Red arenaceous shale, ...	7	0
Red sandstone, ...	3	0
Red arenaceous shale, ...	3	0
Red sandstone, ...	2	0
Red argillaceous shale, ...	8	0
Red sandstone, ...	1	0
Red arenaceous shale, ...	5	0
Red sandstone, ...	1	0
Red argillaceous shale, ...	6	0
Red sandstone, ...	1	0
Red argillaceous shale, ...	28	0
Red arenaceous shale, ...	2	0
Red argillaceous shale, ...	15	0
	2082	0

RECAPITULATION.

Sandstone—				
Greenish gray, with occasional drift plants carbonized,	28	0		
Greenish gray, with concretionary limestone, having the aspect of conglomerate, ...	20	0		
			48	0
Reddish gray, with occasional drift plants carbonized,	104	0		
Reddish gray, with concretionary limestone, ...	16	0		
			120	0

Shale—				
Red argillaceous, ...	640 0			
Red arenaceous, ...	230 0			
		870 0		
Green argillaceous, ...		4 0		
			874 0	
Measures not well exposed, but probably composed of red shale and sandstone,			740 0	
				2082 0

6.

Greenish gray or drab coloured sandstone, fit for grindstones of good quality, which are extensively quarried from it. This is called the South Reef,	50 0
Red argillaceous shale, ...	14 0
Red sandstone, ...	20 0
Measures concealed, probably red shale, ...	2 0
Red sandstone, ...	3 0
Red sandstone, with probably red shale on the top,	7 0
Measures concealed, but said to be red argillaceous and arenaceouss shale, with occasional beds of red sandstone, ...	103 0
Dark gray argillaceous shale, with a small quantity of fine grit in it. This would be called a fine *bluestone* in some parts of South Wales. At the Joggins, there is usually a bed of it above a good grindstone reef, ...	4 0
Greenish gray or drab coloured sandstone, fit for grindstones of the very best quality. The whole reef has been quarried away up to the bank, ...	36 0
Greenish gray sandstone, fit for grindstones of good quality. This has been much quarried, ...	17 0
Greenish gray sandstone, fit for grindstones. This has been very much quarried, ...	7 0
Greenish gray sandstone, fit for grindstones. This and the preceding greenish gray sandstones constitute what is called the North Reef, ...	9 0
Red and green argillaceous shale, ...	18 0
Red sandstone of a soft quality, ...	6 0
Red argillaceous shale, ...	14 0
Red argillaceous and arenaceous shale, with 6 bands of red sandstone, ...	27 0
Greenish gray sandstone, ...	7 0

Red argillaceous shale, ...	6	0
Red sandstone, ...	4	0
Red arenaceous shale, ...	4	0
Red argillaceous and arenaceous shale, ...	10	0
Red argillaceous and arenaceous shale and red sandstone, in alternating beds, ...	12	0
Red argillaceous shale, with 2 small beds of red sandstone, ...	21	0
Red sandstone, with bands of red argillaceous shale,	9	0
Red arenaceous shale, with bands of red sandstone,	6	0
Red sandstone, ...	1	0
Red argillo-arenaceous shale, with thin bands of red arenaceous shale and red sandstone,... ...	30	0
Black calcareous bed, no shells visible, ...	0	1
Red and green variegated argillaceous shale, ...	6	0
Green arenaceous shale, ...	1	0
Red arenaceous and argillaceous shale, in alternating beds, ...	4	0
Red argillaceous shale, ...	6	0
Reddish gray sandstone, ...	6	0
Red argillaceous and arenaceous shale, ...	10	0
Red and green variegated shale and sandstone, ...	15	0
Red and green argillaceous shale, ...	4	0
Red and green variegated sandstone, ...	2	0
Red argillaceous shale, ...	12	0
Red and green calcareous band, ...	0	6
Green arenaceous shale, mixed in patches with red arenaceous shale,...	9	0
Red arenaceous shale, of a crumbly character, ...	12	0
Dark gray argillaceous shale, with *ironstone* balls, ...	5	0
1. *Calcareous* shale, ... 1 0		
Dark gray argillaceous shale, ... 3 0		
COALY clay, ... 0 2	4	2
Reddish and dark gray argillaceous and arenaceous shale, crossed by *stigmariæ* leaves, (*underclay*,)	6	0
Gray argillaceous shale, ...	2	0
Dark gray argillo-arenaceous shale, of a fine smooth quality, (*bluestone*,)	7	0
Greenish gray or drab coloured sandstone, fit for grindstones, ...	10	0
Gray arenaceous shale of a fine quality, in even beds,	8	0
Dark gray argillo-arenaceous shale, of a fine smooth quality, such as usually covers grindstone beds,	3	0

Greenish gray sandstone, fit for grindstones. The top part contains large spherical concretions of harder sandstone, with a rusty exterior, and concentric variations of colour. This constitutes Bacon Ledge, ...	54	0
Greenish gray sandstone, with a vast number of drift plants with a coating of coal. It holds also patches of limestone concretions, which have much the aspect of a conglomerate, ...	10	0
Dirty green calcareous concretionary bed. This has so much the appearance of a conglomerate bed with limestone pebbles, that there is some doubt whether it be not so. It is a very irregular bed and holds carbonized plants, ...	4	0
Reddish green argillo-arenaceous shale, ...	1	0
Greenish arenaceous shale of a hard quality, probably fireclay, crossed by *stigmariæ* leaves, (*underclay,*)	8	0
Red and green variegated argillaceous shale, with 2 feet of sandstone, ...	8	0
Red arenaceous shale with green spots, ...	5	0
Green arenaceous shale, ...	1	0
Red arenaceous shale, ...	1	0
Green arenaceous shale, ...	1	0
Red argillaceous shale	2	0
Red and green arenaceous shale, ...	2	0
Red argillaceous shale, ...	1	0
Greenish gray arenaceous shale, ...	3	0
Red and green arenaceous shale, ...	2	0
Red argillaceous shale, ...	3	0
Greenish gray arenaceous shale, ...	4	0
Green clay, ...	0	1
Red argillaceous shale, ...	6	0
Reddish sandstone, ...	1	0
Red argillaceous shale, ...	5	0
Gray argillaceous shale, ...	2	0
2. Coaly clay, probably coal further in the bank, ...	0	1
Red and green argillo-arenaceous shale of a soft quality, crossed by *stigmariæ* leaves, (*underclay,*)	3	0
Red and green crumbly argillo-arenaceous shale, rather harder than the preceding, crossed by *stigmariæ* leaves, (*underclay,*)	6	0
Reddish sandstone, no stigmariæ visible, ...	0	6
Red crumbly argillo-arenaceous shale, with *stigmariæ* (*underclay,*)	2	0

Red argillo arenaceous shale of a tough crumbly nature, with *stigmariæ* strongly marked (*underclay*,)			2	0
Red argillaceous shale, with thin green bands, and nodules of *ironstone*, a tough crumbly mass, ...			6	0
3. *Carbonaceous shale*, ...	0	1		
Greenish argillaceous shale, ...	0	6		
Carbonaceous shale, ...	0	1		
Greenish argillaceous shale, ...	2	6		
Carbonaceous shale, ...	0	3		
Greenish argillaceous shale in thin leaves,	0	1		
Coaly matter and *carboneous shale*, ...	0	3		
			3	9
Green argillo-arenaceous shale of a soft quality, crossed by *stigmariæ* leaves, (*underclay*,) ...			3	0
Gray argillo-arenaceous shale, rather harder than the preceding, with *stigmariæ* leaves and many nodules of *ironstone* at the top where the bed is more arenaceous (*underclay*,)			4	0
Gray sandstone, with *stigmariæ* leaves (*underlcay*),			1	0
Green argillo-arenaceous shale of a rather soft quality, with *stigmariæ* leaves (*underclay*,) ...			4	0
4. Coal and *carbonaceous shale*, ...			0	3
Green argillo-arenaceous shale, with *stigmariæ* leaves (*underclay*), ...			2	0
Red and green tough crumbly arenaceous shale, with *stigmariæ* branches and leaves (*underclay*), ...			2	0
Red and green tough crumbly claystone, with balls of *argillaceous iron ore*, *stigmariæ* leaves crossing the bed (*underclay*), ...			2	0
Gray rough sandstone and tough crumbly red and green arenaceous shale; one *stigmariæ* branch visible without leaves, but leaves exist in other parts of the bed (*underclay*), ...			4	0
Red and green tough crumbly clay, some very like *underclay*, but no *stigmariæ* leaves visible, ...			2	0
Dark gray argillaceous shale, no *stigmariæ* visible, but the mass tough and crumbly, ...			1	0
Reddish argillo-arenaceous shale, with *stigmariæ* branches and leaves (*underclay*), ...			2	0
Red sandstone with green spots, ...			3	0
Red and green variegated sandstone, the green in spots, ...			3	0
Gray argillaceous shale, ...			3	0
5. Coaly matter, ...			0	0⅛

Greenish arenaceous shale, with *stigmariæ* branches and leaves, the recumbent branches crossing one another and running in all directions (*underclay*),	8	0
Green sandstone, ...	2	0
(From the succeeding bed there starts an upright *sigillaria* about 1 foot in diameter, only 2 feet of the length are visible.)		
6. *Carbonaceous shale*, ...	0	3
Gray argillo-arenaceous shale, with *stigmariæ* leaves (*underclay*), ...	6	0
Greenish gray sandstone, with *stigmariæ* leaves (*underclay*), ...	4	0
Greenish gray sandstone, with *stigmariæ* branches and leaves (*underclay*,)	2	0
Red argillo-arenaceous shale, with *stigmariæ* leaves (*underclay*), ...	3	0
(In these 15 feet of underclay there is a beautiful exhibition of stigmariæ. They are not very abundant, that is to say, in such profuse confusion as usual, but each plant is very distinct. One branch floats along just beneath the surface of the 2 feet bed mentioned, and 24 feet of its length are finely exposed without interruption. The leaves radiate from it distinctly, and individual leaves can be followed down 5 feet, crossing both the hard and the soft parts of the deposit continuously, and others can be traced 2 feet upwards. Where the branch enters a projecting part of the bed, its measurement is 2 inches vertically by 3 inches horizontally, and where the other extremity is lost beneath the beach the measurement is about the same ; so that I could not come to any conclusion as to the direction in which the branch issues from the stem, if it has one. *See fig.* 8.)		
Greenish gray or drab sandstone in irregular beds,...	70	0
Greenish gray sandstone, with a vast quantity of drift plants lying in confusion and coated with coal. In one of the beds there appears a bundle of no less than 10 plants squeezed together side by side, as represented in fig. 8. Each has a core of sandstone surrounded by a good thick coating of crystallized coal. They run through and through a projecting ledge of 10 feet, (see fig. 9,) and lie rather oblique to the plane of		

the bed, but conformably with its elementary layers, ...			30	0
Greenish gray sandstone, with some spherical concretions of a harder quality, with a rusty exterior, ...			50	0
Greenish gray sandstone, ...			22	0
Dark gray argillaceous shale, ...			0	6
Greenish gray arenaceous shale, with some fibrous impressions like *stigmariæ* leaves crossing the bed (*underclay*), ...			2	0
Red argillaceous shale, ...			0	6
Greenish gray arenaceous shale, ...			0	6
Red argillaceous shale, ...			2	0
Green arenaceous shale, ...			2	0
Greenish gray sandstone, with spherical concretions,			4	0
Greenish gray sandstone and shale, ...			5	0
Greenish gray sandstone, ...			1	0
Gray argillaceous shale, ...			0	10
Gray rough crumbly sandstone, ...			5	0
Gray calcareous sandstone, ...			0	6
7. *Bituminous limestone*, ...	0	3		
Gray argillaceous shale, ...	3	0		
Gray calcareous bed, ...	0	2		
Carbonaceous shale, ...	0	6		
Bituminous limestone, with *shells* and *fish scales*; *fish jaws* occur, ...	0	3		
Carbonaceous shale, being a mass of platted plants, apparently grasses, ...	1	0		
COAL, ...	0	1		
			5	3
Gray argillo-arenaceous shale, with *stigmariæ* (*underclay*), ...			5	0
Gray arenaceous shale, ...			5	0
Greenish gray sandstone, ...			7	0
Gray arenaceous shale, ...			2	0
Greenish gray sandstone, ...			1	0
Gray arenaceous shale, ...			2	6
Greenish gray sandstone, ...			0	6
Gray soft arenaceous shale, ...			4	0
Greenish gray soft flaggy sandstone, with ripple mark,			10	0
Greenish gray soft flaggy sandstone, ...			4	0
Gray arenaceous shale, ...			4	0
Greenish gray sandstone, ...			4	0
Greenish gray soft flaggy sandstone, scarcely standing the weather, ...			14	0

Greenish gray sandstone, in regular beds, ...	27	0
Measures concealed, but no doubt soft, probably argillaceous shale, with a mixture of arenaceous,...	100	0
Gray arenaceous shale, ...	8	0
Gray argillaceous shale, ...	6	0
Greenish gray sandstone, fit for grindstones. This has been quarried to a considerable extent, and worked deep into the bank It is the best quarry of this reef, but the stone is rather too hard, ...	10	0
Greenish gray sandstone of grindstone quality, ...	6	0
Greenish gray sandstone. This has been worked for grindstones, but the quality is rather hard, ...	14	0
Greenish gray sandstone fit for grindstones, but rather too hard. This bed exhibits spherical concretions in some parts, some of which are 6 to 8 inches in diameter. These grindstone beds constitute what is called the Upper Cove Reef, ...	18	0
Greenish gray sandstone, ...	34	0
Greenish gray sandstone in flaggy beds, ...	49	0
Greenish gray sandstone of a stronger quality, ...	8	0
Greenish gray sandstone in flaggy beds, ...	15	0
Greenish gray sandstone, ...	34	0
Greenish gray argillaceous shale, ...	9	0
Greenish gray sandstone. This constitutes Boss Point, ...	42	0
Greenish gray sandstone, ...	6	0
Greenish gray sandstone, with drift plants coated with coal, ...	12	0
Greenish gray sandstone in regular beds, ...	28	0
Greenish gray sandstone, with carbonized drift plants,	7	0
Greenish gray sandstone in more regular beds, ...	9	0
Greenish gray sandstone, with drift carbonized plants,	9	0
Greenish gray sandstone, pervaded by a tangled mass of carbonized drift plants, ...	6	0
Greenish gray sandstone, ...	12	0
Gray argillaceous shale, ...	1	0
8. COAL occurring in patches, ...	0	0½
Gray argillo-arenaceous shale, with the aspect of fire-clay, with *stigmariæ* branches and leaves very distinctly exhibited (*underclay*), ...	7	0
Gray arenaceous shale, ...	3	0
Greenish gray argillaceous shale, with nodules of *clay ironstone* disseminated in considerable quantity, ...	5	0
Gray argillaceous shale, ...	10	0

Greenish gray sandstone, ...	18	0
Greenish gray sandstone, with carbonized drift plants in confusion, ...	7	0
Greenish gray sandstone, ...	10	0
Greenish gray sandstone, with carbonized drift plants in confusion, ...	4	0
Greenish gray sandstone, ...	7	0
Greenish gray sandstone, with carbonized drift plants in confusion, ...	3	0
Greenish gray sandstone, ...	15	0
Greenish gray sandstone, with spherical concretions of a harder quality, ...	7	0
Greenish gray sandstone, with a few carbonized drift plants, ...	18	0
Gray arenaceous shale, ...	2	0
Greenish gray sandstone, ...	12	0
Greenish gray sandstone, with a confused multitude of carbonized drift plants, ...	4	0
Greenish gray sandstone, with a few carbonized drift plants, ...	21	0
Greenish sandstone, with calcareous concretionary nodules, having much the aspect of a conglomerate, with limestone pebbles. The bed is very uneven,...	1	0
Greenish gray sandstone, with carbonized drift plants,	13	0
Greenish gray sandstone, in even beds, ...	12	0
Greenish gray sandstone, with carbonized drift plants,	10	0
Greenish gray sandstone, ...	51	0
Gray argillaceous and red argillaceous shale, ...	23	0
Greenish gray sandstone, fit for grindstones, but rather hard. This constitutes Boss Quarry, ...	10	0
Greenish gray sandstone, ...	25	0
Greenish gray sandstone, with carbonized drift plants,	6	0
Greenish gray sandstone, ...	24	0
Greenish gray sandstone, with nodules of *clay ironstone*, casts of *calamites* and other plants, ...	1	0
Gray arenaceous shale, ...	4	0
Red argillaceous shale, ...	6	0
Greenish gray arenaceous shale, ...	3	0
Gray argillaceous shale, ...	12	0
Gray arenaceous shale, ...	3	0
Yellow sandstone, very soft and yielding to the weather, ...	4	0
Gray argillaceous shale, ...	7	0

Yellow sandstone, very soft and yielding to the wether, ...	21	0
Greenish gray sandstone in even beds, ...	4	0
Gray arenaceous shale, ...	4	0
Greenish gray sandstone, fit for grindstones, ...	18	0
Gray arenaceous shale, ...	4	0
Greenish gray sandstone, ...	7	0
Greenish gray sandstone, with carbonized drift plants,	9	0
Greenish gray sandstone in regular beds, ...	21	0
Gray arenaceous shale and sandstone, ...	1	0
Greenish gray sandstone, ...	13	0
Gray argillaceous shale, ...	1	0
Greenish gray sandstone, ...	27	0
Gray argillaceous shale, ...	6	0
Greenish gray sandstone, ...	30	0
Greenish bed with concretions of limestone, very much resembling a calcareous conglomerate, ...	5	0
Gray argillaceous shale, ...	5	0
Greenish bed of calcareous concretions, very much resembling a calcareous conglomerate ...	9	0
Gray arenaceous shale, with some bands of sandstone, ...	23	0
Greenish gray sandstone, ...	64	0
Greenish gray sandstone, ...	27	0
(Here there appears to be a small fault. It does not disturb the strike, but the dislocation, if there is any, is not ascertained. I do not think it can be many yards.)		
Greenish gray sandstone, ...	34	0
Greenish gray sandstone, with many carbonized drift plants, ...	14	0
Greenish gray sandstone, more regular in the beds,	16	0
Greenish gray sandstone, with some carbonized drift plants, ...	18	0
Greenish gray sandstone, with many carbonized drift plants in great confusion, ...	9	0
Greenish bed with calcareous concretions, having much the aspect of a calcareous conglomerate,...	1	0
Greenish gray sandstone with many prostrate carbonized drift plants, ...	9	0
Greenish gray sandstone, a solid mass without divisions, ...	21	0
Greenish gray sandstone, with a vast and confused collection of carbonized drift plants, one lying prostrate measured 25 feet in length and about 1 foot in diameter, at the small end, ...	19	0

Greenish gray sandstone more regular, ...	117	0
Greenish gray sandstone with carbonized drift plants, and holding small patches of concretionary nodulous limestone very like conglomerate, ...	39	0
Gray arenaceous shale, with small *clay ironstone* balls desseminated. This has something of the character of underclay but the *stigmariæ* are not distinct, ...	4	0
Gray arenaceous shale, ...	1	0
Gray argillaceous shale, ...	3	0
Gray arenaceous shale, ...	3	0
Gray argillaceous shale with some balls of *clay ironstone*, ...	5	0
Gray arenaceous shale, ...	1	0
Gray argillaceous shale with 2 beds of arenaceous shale, ...	8	0
Greenish gray sandstone in regular beds, ...	61	0
Greenish gray sandstone, with carbonized drift plants, and occasional patches of concretionary nodulous limestone, very like conglomerate, ...	63	0
Greenish gray sandstone with carbonized drift plants.	1	0
Greenish gray sandstone fit for grindstones, ...	20	0
Gray concretionary limestone, very like a conglomerate with calcareous pebbles, ...	4	0
Greenish gray sandstone, ...	25	0
Lead gray concretionary limestone with carbonized drift plants, and mixed up with calcareous sandstone, ...	8	0
Gray argillaceous shale, ...	10	0
Red or chocolate coloured argillaceous shale. ...	40	0
Dark gray coarse limestone, no organic remains visible, ...	1	0
Gray argillaceous shale, ...	1	0
9. COALY matter and *carbonaceous shale*, ...	0	2
Gray argillo-arenaceous shale, resembling fireclay with the leaves and branches of *stigmariæ ficoides* strongly marked, the branches recumbent, and near the top of the bed *ironstone* balls are disseminated through the deposit. (*underclay*.) ...	5	0
Gray argillaceous shale and greenish gray sandstone, ...	2	0
Gray argillaceous shale, ...	2	0
Red argillaceous shale, ...	5	0
Greenish argillaceous shale, ...	7	0
Greenish gray sandstone, ...	96	0

Greenish concretionary limestone,	... ...	2	0
Greenish gray hard sandstone with a number of large spherical masses still harder. Some of them are 1 foot in diameter, and in section exhibit beautiful deep black and bright red concentric circles towards the exterior. These spheres are said to be occasionally 4 feet in diameter. This constitutes Dogfish Reef,	...	20	0
Greenish concretionary limestone, the calcareous concretions are lodged in an argillaceous matrix,	...	1	0
Gray argillaceous shale,	... ...	12	0
Greenish gray sandstone,	... ...	6	0
Measures concealed, but supposed to be soft,	...	3	0
Dark gray argillaceous shale with disseminated *clay ironstone* balls,	... ...	10	0
Dark gray argillaceous shale with a course of *clay ironstone* balls at the bottom, some of them 6 inches in diameter,	... ...	5	0
Black carbonaceous shale, with *shells* in some parts,		4	0
Dark gray argillaceous shale,	... ...	0	10
Dark gray argillaceous shale with a course of poor *ironstone* balls at the top, making about ½ inch,		8	0
Greenish gray sandstone fit for grindstones,	...	17	0
Greenish concretionary limestone, having much the appearance of a calcareous conglomerate,	...	3	0
Greenish gray sandstone,	... ...	5	0
Greenish gray sandstone with carbonized drift pants, *calamites* and others squeezed flat,	... ...	3	0
Brown argillaceous shale,	... ...	1	0
Greenish gray sandstone,	... ...	1	0
Reddish gray shale,	... ...	1	0
Measures concealed, probably shale,	... ...	77	0
Red or chocolate coloured sandstone,	... ...	3	0
Red or chocolate coloured arenaceous shale,	...	7	0
Red or chocolate coloured sandstone and shale,	...	21	0
Red sandstone,	... ...	1	0
Red shale,	... ...	1	0
Red sandstone,	... ...	6	0
Red shale,	... ...	1	0
Red sandstone,	... ...	2	0
Red arenaceous shale,	... ...	1	0
Red sandstone,	... ...	10	0
Red shale,	... ...	2	0
Red sandstone,	... ...	0	6
Red shale,	... ...	0	8

Dark green limestone, ...	0	4
Red shale, ...	3	0
Red sandstone, ...	2	0
Red argillaceous shale, ...	6	0
Greenish argillaceous shale, ...	0	3
Red or chocolate coloured shale, ...	1	0
Red or chocolate coloured sandstone, ...	1	0
Red or chocolate coloured shale, ...	8	0
Black bitnminous limestone, ...	0	3
Red or chocolate coloured shale, ...	1	0
Black bituminous limestone, ...	0	6
Red or chocolate coloured argillaceous shale, ...	1	6
Black bituminous limestone, with *fish scales*, ...	0	6
Brownish red soft shale, ...	52	0
Red or chocolate coloured shale, ...	18	0
Greenish gray sandstone, ...	9	0
Red shale, ...	37	0
Black bitnminous limestone, with *fish scales*, ...	0	6
	3240	9

RECAPITULATION.

Coal in 9 seams, ...	0	10		
Carbonaceous shale associated with the coal, and in one instance without coal, and then containing remains of shells,	7	4		
Bituminous limestone with remains of fish, and calcareous beds, associated with the coal and carbonaceous shale seams in one instance, and in six instances independant, ...	4	10		
Greenish and gray argillaceous shale, associated in some instances with the coal and carbonaceous seams,... ...	9	1		
			22	1
Underclay or understone, being beds of various material, immediately subjacent to the seams of coal and carbonaceous shale, and invariably pe-				

netrated by the recumbent branches and radiating leaves of the stigmaria ficoïdes. Every one of the coal seams rests upon a stigmaria bed, and there is one instance of the stigmaria bed without superincumbent coal. The material of which the stigmaria beds consists is as follows:						
Sandstone of a gray colour and crumbly quality, ...			5	0		
Shale—						
Gray argillo-arenaceous, frequently fit for fireclay, ...	50	0				
Green argillo-arenaceous, ...	21	0				
Red and green argillo-arenaceous,	17	0				
			88	0		
					93	0
Sandstone—						
Greenish gray or drab coloured, of which much is fit for the purpose of good grindstones, and it is in it that the chief quarries of the Joggins exist. Of this mass 350 feet in various parts are filled with vast collections of drift plants, coated with crystalline coal. The plants are in great confusion, and are in general prostrate. Spherical concretions some 4 feet in diameter with a rusty black exterior, occur in 51 feet of it, ...			1886	6		
Greenish, ...			2	0		
Yellow of a finer but less durable quality than the drab,			25	0		
Reddish gray (and gray 5,) ...			19	6		
Red and green, ...			15	0		
Red and chocolate colored, ...			95	6		
					2043	6

Limestone of a concretioary character very much resembling conglomerate generally of a greenish colour and in very irregular layers, ...			43	0		
Shale—						
Greenish gray arenaceous and argillaceous, ...	136	0				
Gray arenaceous and argillaceous with a few small beds containing ironstone balls, ...	234	0				
Red and green variegated, ...	77	0				
Red and chocolate coloured, ...	592	2				
			1039	2		
					3240	9

(Among the organic remains is to be remarked one upright sigillaria.)

7.

Measures concealed, ...	19	0
Red arenaceous shale, ...	1	0
Measures concealed, ...	37	0
Red arenaceous shale, ...	1	0
Measures concealed, probably red shale, ...	139	0

(Here is said to occur a bed of gypsum. I am informed that it has been occasionally seen when the beach was washed clean by the tide. A fragmentary mass of gypsum of about half a hundred weight lay on the beach.)

Measures, concealed, probably red shale,... ...	85	0
Red sandstone conglomerate with white, red, yellow and black silicious pebbles. The black is lydian stone, the others are quartz. The pebbles vary in size from that of a pea to that of a hen's egg,	105	0
Red sandstone conglomerate of a coarser quality. The pebbles are of the same colour, but some of them would weigh two pounds, ...	3	0
Red sandstone conglomerate, not quite so coarse, ...	16	0
Red arenaceous shale with several bands of sandstone, ...	21	0
Red sandstone, ...	5	0
Red shale, ...	3	0
Red sandstone, ...	6	0

Red shale, ...	3	0
Red sandstone conglomerate with white, gray and black silicious pebbles as before, ...	16	0
Red sandstone, ...	22	0
Red and green spotty variegated sandstone, ...	11	0
Red sandstone of soft quality, ...	3	0
Red and green spotty variegated sandstone. The green colour constitutes the spots which are circular with a black speck in the centre. The bed appears to be partly calcareous, ...	9	0
Red sandstone of a soft quality and red arenaceous shale, ...	11	0
Red arenaceous shale, ...	24	0
Red sandstone conglomerate with white, red and yellow quartz, and black lydian stone pebbles, varying in size from that of a pea to that of an egg, ...	17	0
Red sandstone of a very coarse grit, with streaks of white parallel with the bedding, ...	16	0
Red sandstone conglomerate with quartz and limestone pebbles. The matrix is coarse, ...	4	0
Red sandstone with thin white streaks deposited in it, ...	35	0

(This bed is cut by a regular vein of sulphate of barytes 3 inches wide. Its colour is tinged with red. The course of the vein is N. & S. The underlie E. < 82°)

Red sandstone conglomerate. The bed is very uneven and contains calcareous material, ...	3	0
Greenish concretionary limestone, looking very like a conglomerate with limestone pebbles, ...	8	0
Greenish gray sandstone, ...	1	0
Greenish concretionary limestone as before, ...	3	0
Reddish sandstone, ...	7	0
Greenish concretionary limestone as before, ...	5	0
Red or chocolate coloured shale, ...	8	0
Red sandstone, ...	2	0
Red or chocolate coloured shale, ...	1	0
	650	0

Limestone of a concretioary character very much resembling conglomerate generally of a greenish colour and in very irregular layers, ...		43 0	
Shale—			
Greenish gray arenaceous and argillaceous, ...	136 0		
Gray arenaceous and argillaceous with a few small beds containing ironstone balls, ...	234 0		
Red and green variegated, ...	77 0		
Red and chocolate coloured, ...	592 2		
		1039 2	
			3240 9

(Among the organic remains is to be remarked one upright sigillaria.)

7.

Measures concealed, ...	19 0
Red arenaceous shale, ...	1 0
Measures concealed, ...	37 0
Red arenaceous shale, ...	1 0
Measures concealed, probably red shale, ...	139 0
(Here is said to occur a bed of gypsum. I am informed that it has been occasionally seen when the beach was washed clean by the tide. A fragmentary mass of gypsum of about half a hundred weight lay on the beach.)	
Measures, concealed, probably red shale,... ...	85 0
Red sandstone conglomerate with white, red, yellow and black silicious pebbles. The black is lydian stone, the others are quartz. The pebbles vary in size from that of a pea to that of a hen's egg,	105 0
Red sandstone conglomerate of a coarser quality. The pebbles are of the same colour, but some of them would weigh two pounds, ...	3 0
Red sandstone conglomerate, not quite so coarse, ...	16 0
Red arenaceous shale with several bands of sandstone, ...	21 0
Red sandstone, ...	5 0
Red shale, ...	3 0
Red sandstone, ...	6 0

Red shale, ...	3	0
Red sandstone conglomerate with white, gray and black silicious pebbles as before, ...	16	0
Red sandstone, ...	22	0
Red and green spotty variegated sandstone, ...	11	0
Red sandstone of soft quality, ...	3	0
Red and green spotty variegated sandstone. The green colour constitutes the spots which are circular with a black speck in the centre. The bed appears to be partly calcareous, ...	9	0
Red sandstone of a soft quality and red arenaceous shale, ...	11	0
Red arenaceous shale, ...	24	0
Red sandstone conglomerate with white, red and yellow quartz, and black lydian stone pebbles, varying in size from that of a pea to that of an egg, ...	17	0
Red sandstone of a very coarse grit, with streaks of white parallel with the bedding, ...	16	0
Red sandstone conglomerate with quartz and limestone pebbles. The matrix is coarse, ...	4	0
Red sandstone with thin white streaks deposited in it, ...	35	0

(This bed is cut by a regular vein of sulphate of barytes 3 inches wide. Its colour is tinged with red. The course of the vein is N. & S. The underlie E. $<$ 82°)

Red sandstone conglomerate. The bed is very uneven and contains calcareous material, ...	3	0
Greenish concretionary limestone, looking very like a conglomerate with limestone pebbles, ...	8	0
Greenish gray sandstone, ...	1	0
Greenish concretionary limestone as before, ...	3	0
Reddish sandstone, ...	7	0
Greenish concretionary limestone as before, ...	5	0
Red or chocolate coloured shale, ...	8	0
Red sandstone, ...	2	0
Red or chocolate coloured shale, ...	1	0
	650	0

RECAPITULATION.

Sandstone—				
Greenish gray, ...	1 0			
Reddish, ...	7 0			
Red and green, ...	20 0			
Red, ...	65 0			
		93 0		
Red with white streaks, ...		51 0		
			144 0	
Conglomerate, with red, white, gray and yellow quartz and black lydian stone pebbles, in a matrix of red sandstone,			148 0	
Limestone in concretionary nodules placed in a matrix of greenish sandstone and shale, occasionally associated with carbonized fragments of plants, ...			16 0	
Shale—				
Deep red and chocolate red, arenaceous, ...		62 0		
Measures concealed, but supposed to be of the same quality, ...		280 0		
			342 0	
				650 0

8.

Greenish gray sandstone, red towards the top, ...	12 0
Greenish gray arenaceous limestone, with a band of concretionary limestone, resembling conglomerate, ...	6 0
Greenish concretionary limestone and coarse sandstone, with carbonized drift plants, ...	1 0
Greenish gray sandstone, ...	11 0
Greenish gray sandstone, with two bands of concretionary limestone, ...	12 0
Reddish black and reddish brown shale, with beds containing calcareous septariæ, ...	9 0
Dark gray sandstone, with nodules of concretionary limestone, ...	2 0
Reddish black argillaceous shale, with nodules of ferruginous limestone, ...	9 0
Greenish gray sandstone, ...	30 0

Greenish concretionary limestone, ...	1	0
Greenish gray sandstone, ...	21	0
Greenish concretionary limestone, with carbonized drift plants, ...	3	0
Greenish gray sandstone, ...	17	0
Greenish concretionary limestone, ...	1	0
Greenish gray or drab coloured sandstone, ...	4	0
Red shale, ...	8	0
Red sandstone, ...	12	0
Red shale, with some bands of soft red sandstone, ...	37	0
Red sandstone of a soft quality,...	6	0
Red shale, with bands of red sandstone, ...	40	0
Greenish gray sandstone, ...	30	0
Greenish concretionary limestone, ...	1	0
Greenish gray sandstone, 10 feet; greenish concretionary limestone, 2 feet, ...	12	0
Greenish gray sandstone, at the bottom of which there is a layer of carbonized drift plants, occasionally replaced by *gray sulphuret of copper* invested with a thin pellicle of the *green carbonate*, ...	8	0
Red shale, ...	8	0
Red sandstone, ...	17	0
Red shale, ...	3	0
Greenish gray sandstone, at the bottom of which is a layer of drift plants converted into coal, and occasionally replaced by *gray sulphuret of copper* invested with the *green carbonate*, ...	6	0
Red shale, ...	9	0
Red shale and red sandstone, ...	10	0
Red shale, ...	10	0
Red sandstone, ...	7	0
Red shale, ...	8	0
Red and greenish gray sandstone, ...	19	0
Greenish gray sandstone, with drift plants converted into coal, and occasionally replaced by *gray sulphuret of copper* with *green carbonate*, ...	1	0
Red arenaceous shale,...	37	0
Red sandstone of a soft quality,...	16	0
Greenish gray sandstone, ...	6	0
Red hard arenaceous shale, ...	25	0
Reddish sandstone, ...	13	0
Red shale, ...	2	0
Greenish gray sandstone, with carbonized remains of plants, ...	6	0

Greenish concretionary limestone, 2 feet; red shale, 1 foot, ...	3	0
Greenish gray sandstone, with concretionary limestone and carbonized remains of plants at the bottom,...	11	0
Greenish gray sandstone, with one foot of red shale on top, ...	3	0
Red shale, ...	16	0
Red sandstone, with some of a drab colour at the bottom, with carbonized remains of plants and balls of argillaceous shale, ...	12	0
Red arenaceous shale,...	3	0
Red sandstone, ...	3	0
Red arenaceous shale,...	60	0
Red sandstone of a coarse quality, ...	14	0
Greenish gray sandstone, coloured red in parts, ...	10	0
Red arenaceous shale,...	4	0
Greenish gray sandstone, with remains of plants converted into coal, ...	6	0
Red arenaceous shale,...	30	0
Red sandstone fit for first quality of flagging, ...	15	0
Greenish gray sandstone, with many remains of plants converted into coal, and occasionally replaced by *gray sulphuret of copper* with a pellicle of *green carbonate* around it, ...	6	0
Red arenaceous shale,...	14	0
Red sandstone fit for flagging, ...	16	0
Red arenaceous shale,...	16	0
Red sandstone fit for inferior flagging, ...	3	0
Red arenaceous shale,...	100	0
Red sandstone fit for flagging, ...	4	0
Red arenaceous shale,...	29	0
Red sandstone fit for flagging, ...	6	0
Red arenaceous shale,...	39	0
Red sandstone fit for flagging, ...	30	0
Red arenaceous shale, with two bands of red sandstone, ...	19	0
Red sandstone fit for flagging, ...	22	0
Red arenaceous shale,...	119	0
(Here is said to occur gypsum of a red colour, in small quantities, but the bank being rather obscured by debris it was not visible.)		
Red arenaceous shale,...	108	0
Red arenaceous shale, with bands of red sandstone,	3	0

Red arenaceous shale,...	79	0
Red arenaceous shale, with bands of red sandstone,	3	0
Red arenaceous shale,...	43	0
Red arenaceous shale, with green veins crossing it,	19	0
Red sandstone, ...	1	0
Red arenaceous shale,...	2	0
Red sandstone, ...	1	0
Red arenaceous shale,...	39	0
Red sandstone, partly greenish gray, ...	4	0
Red arenaceous shale,...	1	0
Red sandstone of a soft quality, ...	3	0
Red arenaceous shale,...	12	0
Red sandstone, ...	1	0
Red arenaceous shale,...	14	0
Red arenaceous shale of a hard quality, with a band of red sandstone above, ...	9	0
Red sandstone of a soft quality, ...	1	0
Measures concealed, probably red shale, ...	4	0
Red arenaceous shale, with a band of greenish gray sandstone above, ...	14	0
Red arenaceous shale,...	10	0
Measures not well seen, but probably red arenaceous shale, ...	27	0
Red arenaceous shale, with a band of red sandstone above, ...	7	0
Red hard arenaceous shale, ...	1	0
Measures concealed, but probably arenaceous shale,	15	0
Red arenaceous shale,...	53	0
Measures concealed, but probably red arenaceous shale of the same quality as before. Here occurs Seaman's Brook, Mill Cove, ...	73	0
	1658	0

(In the exact strike of the lower gypsum above mentioned, in its course to Hebert River, there is a sink-hole about half way, in which gypsum has been found by excavation; and where the strike would come upon the Hebert, a mass of the mineral, apparently in situ, is seen in the bank, with red shale on both sides of it. At such a distance to the north of this mass as gives a vertical thickness of 300 feet of subjacent red shale, there is exposed a deposit of limestone, which, with some associated strata, appears to be about 100 feet thick; and this may, therefore, be considered as terminating the foregoing section. The limestone contains organic remains, among which there is, in some abundance, a bivalve shell, which I recognise as identical with the *producta Lyelli* of Windsor, in Nova Scotia.)

RECAPITULATION.

Sandstone—							
Greenish gray, occasionally holding carbonized remains of plants, and in four instances the plants (underlying the sandstone) are replaced by gray sulphuret and green carbonate of copper, ...	206	0					
Reddish, ...	13	0					
Deep red, ...	213	0					
			432	0			
Concretionary limestone associated with the greenish gray sandstone. The concretions are held in an argillo-arenaceous matrix. In one instance the whole of the bed is calcareous, and there occur 9 beds altogether, ...			20	0			
Shale—							
Red arenaceous, sometimes more and sometimes less argillaceous, ...	1186	0					
Reddish black and gray, with calcareous septaria and nodules, ...	20	0					
			1206	0			
					1658	0	

TOTAL THICKNESS.

No. 1, ...	1617	0
" 2, ...	650	0
" 3, ...	2134	1
" 4, ...	2539	1
" 5, ...	2082	0
" 6, ...	3240	9
" 7, ...	650	0
" 8, ...	1658	0
	14570	11

Fig. 5.

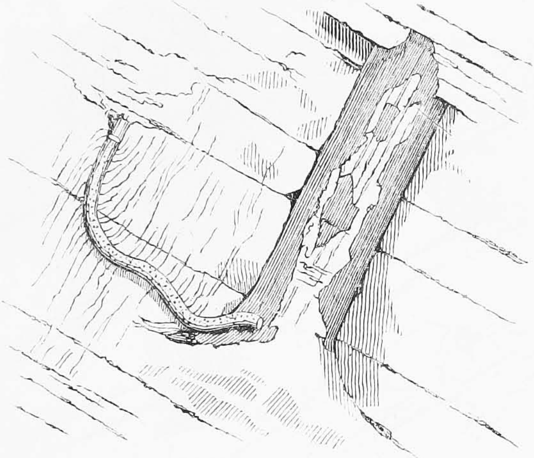


Fig. 6.

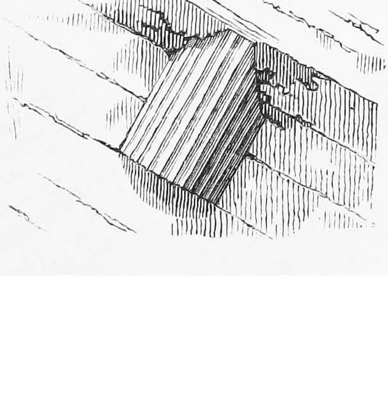


Fig. 7.

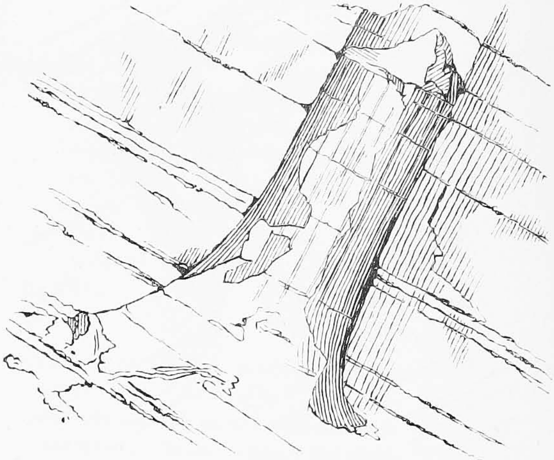


Fig. 8.

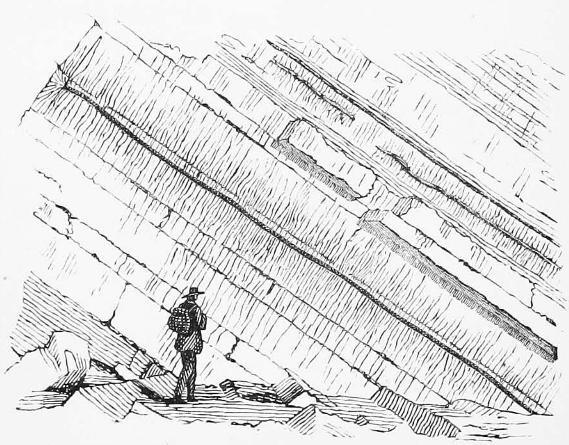


Fig. 9.

FRONT VIEW

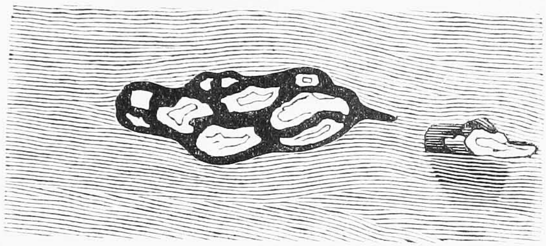


Fig. 10.

SIDE VIEW