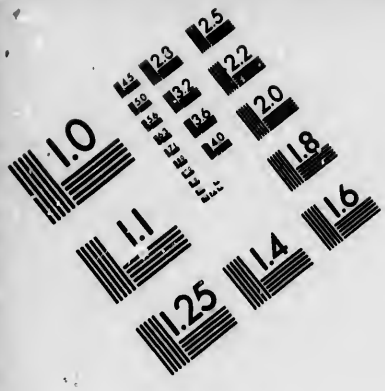

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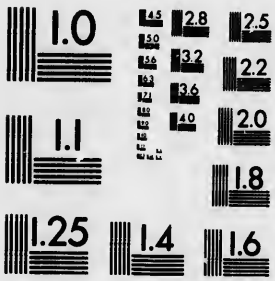

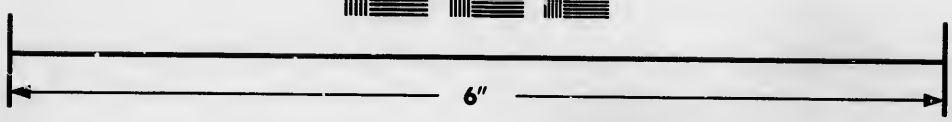

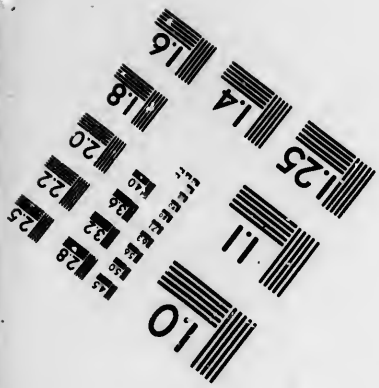

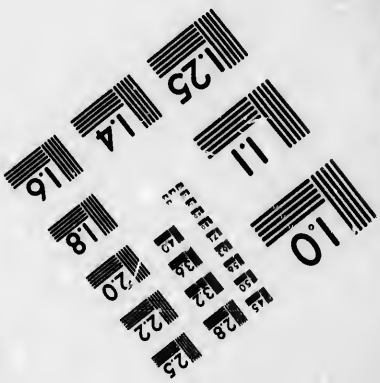

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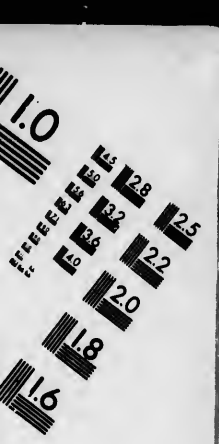

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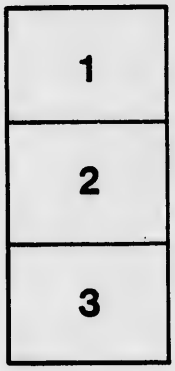
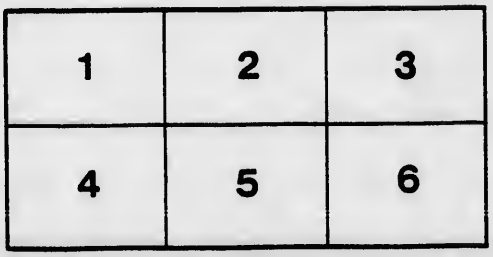




REPORTS

ON THE

GEOLOGICAL RELATIONS, CHEMICAL ANALYSES,

AND

MICROSCOPIC EXAMINATION

OF THE

COAL

OF

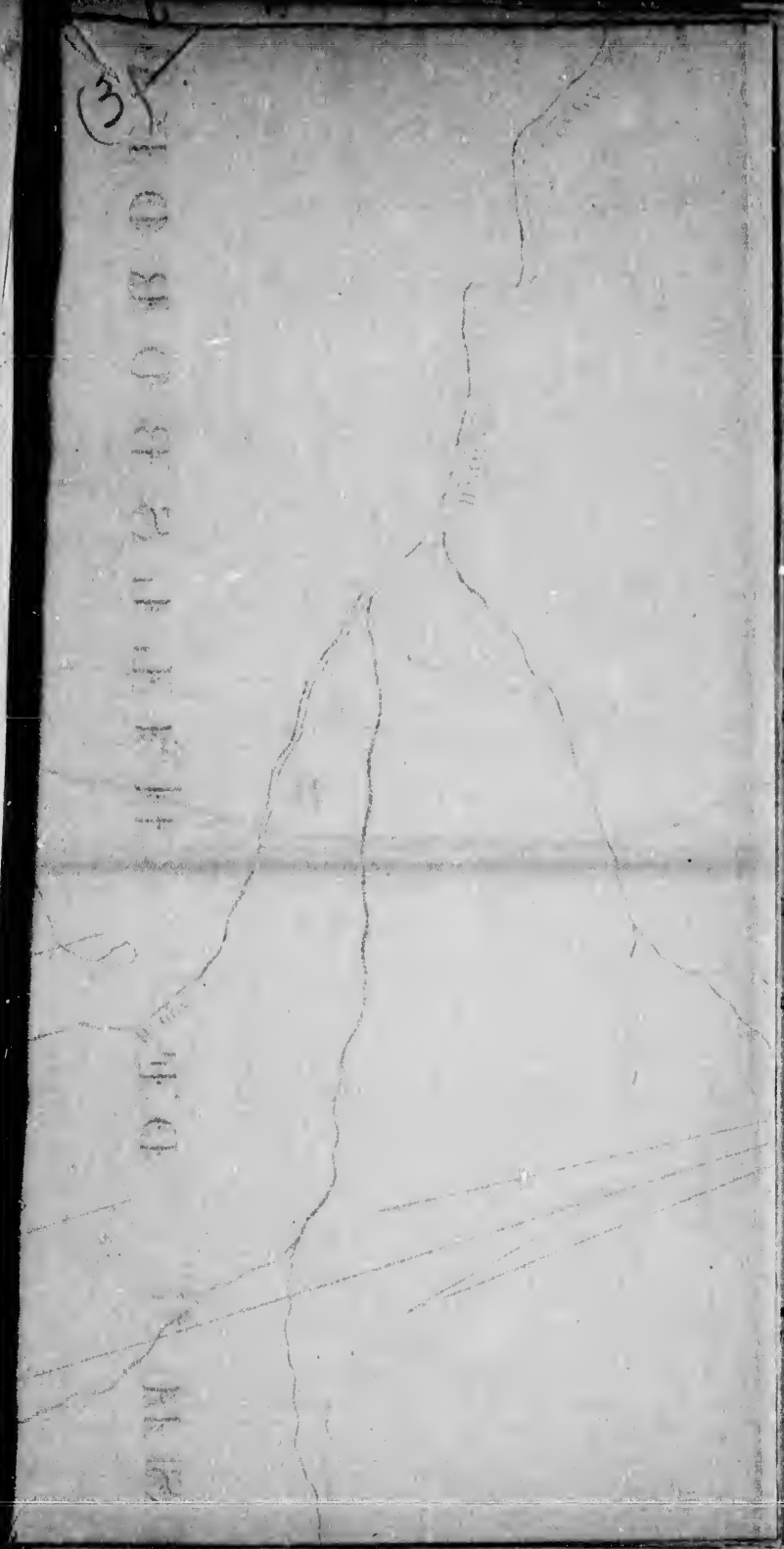
THE ALBERT COAL MINING CO.,

SITUATED IN

HILLSBORO, ALBERT CO., NEW BRUNSWICK.

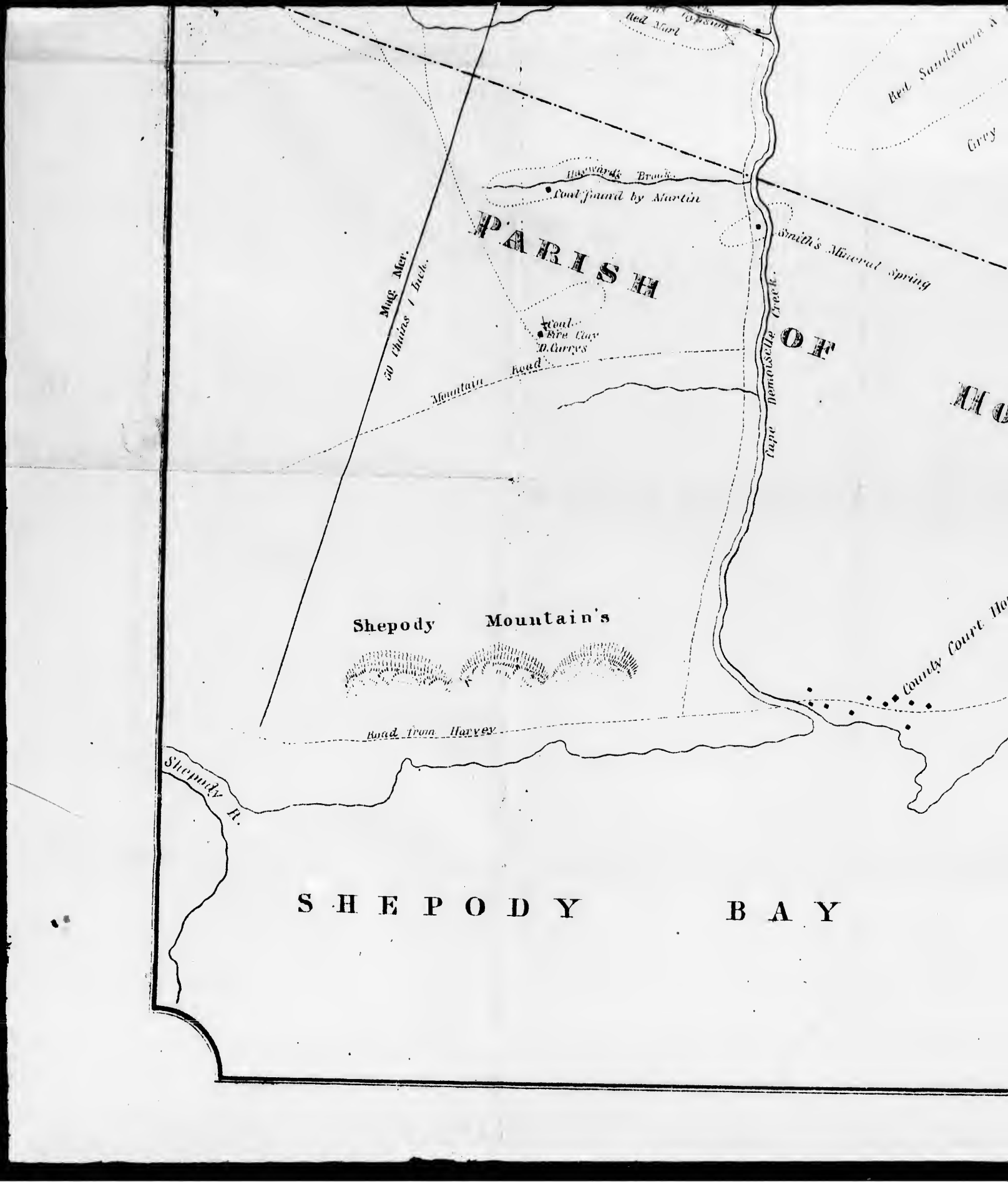
NEW-YORK:
GEORGE F. NESBITT & CO., PRINTERS AND STATIONERS
CORNER WALL AND WATER STREETS.

1851.




Green Novaculite
Stephen's Farm
Shales
Baizeley's Farm
Road From Caledonia Mills
Turtle Creek
Mill
PARISH OF HIL
Brook
Rawlen's Gypsum Quarry
DUFFY LEASE
Road From Mills
Coal. Shales
ALBERT MINE
FOULIS LEASE
ALLISON LEASE
Brown
Road from Caledonia
Gas Spring
Steadon
Conglomerate
School House
FULLER
Gypsum
Lime
Mill
Millon
LEASE
Conglomerate
Lime
Sienite
Novaculite
Granite
Conglomerate
Gypsum
Thick Plaster Rocks
Anhydrous Gypsum
Red Marl
Grey Sandstone
Red Sandstone


Stony Creek
Weldons
Creek
HILLSBOROUGH
Road
Gypsum
Red Marl
Tyler's Mills
Conglomerate
Limestone
Gypsum
Grey Sandstone
Cape Nemouselle Road
Red Sandstone & Red Marl
Grey Sandstone
Conglomerate
Cairns
Limestone
Conglomerate
Edgers
Cross
Conglomerate
Red Sandstone
Frenchs
RIVER
ODIAC


Red Marl
Red Sandstone
Grey
Hayward's Brook
Coal found by Martin
Smith's Mineral Spring
PARISH
OF
Mag. Mer.
30 Chains 1 Link.
Coal
Fire Clay
D. Carrys
Mountain Road
Cape Demoiselle Creek.
Shepody Mountain's
County Court Ho
Road from Harvey
Shepody R.
SHEPODY BAY

A GEOLOGICAL MAP
of the ALBERT COAL MINES,
AND THE SURROUNDING STRATA.

Geologically Examined

By DR. CHARLES T. JACKSON.

Assisted by

R. FOLLIS Esq.

Containing also the Geol. Observations of

Dr. James G. Percival.

C. Cook's Lith. 81 Washington St., (Jay's Building) Boston.

Dr Webster

(3)

REPORT

ON THE

ALBERT COAL MINE,

CONTAINING

☞ The Map and Plates referred to in Dr. JACKSON's Report are in the hands of the engravers. The latter requiring the personal attention of Mr. SONREL, will not be completed before January.

ROCKS, INCLUDING AND ACCOMPANYING THE COAL;

WITH LITHOGRAPHIC DRAWINGS OF THE FOSSIL FISHES AND PLANTS FOUND IN THE MINE, TOGETHER WITH DESCRIPTIONS OF THE SPECIMENS, CHEMICAL RESEARCHES ON THE COAL, AND TABLES OF COMPARISON WITH DIFFERENT VARIETIES OF ASPHALTUM.

BY CHARLES T. JACKSON, M. D., F. G. S. F.,

KNIGHT OF THE NATIONAL ORDER OF THE LEGION OF HONOR, LATE GEOLOGIST TO THE STATES OF MAINE, NEW HAMPSHIRE, RHODE ISLAND, AND OF THE MINERAL LANDS OF THE UNITED STATES IN MICHIGAN, ASSAYER TO THE STATE OF MASSACHUSETTS, VICE PRESIDENT OF THE BOSTON SOCIETY OF NATURAL HISTORY, &C.

Dr Webster

(3)

REPORT

ON THE

ALBERT COAL MINE,

CONTAINING

AN ACCOUNT OF THE SITUATION AND

GEOLOGICAL RELATIONS

OF THE

ROCKS, INCLUDING AND ACCOMPANYING THE COAL;

WITH LITHOGRAPHIC DRAWINGS OF THE FOSSIL FISHES AND PLANTS FOUND IN THE MINE, TOGETHER WITH DESCRIPTIONS OF THE SPECIMENS, CHEMICAL RESEARCHES ON THE COAL, AND TABLES OF COMPARISON WITH DIFFERENT VARIETIES OF ASPHALTUM.

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REPORT.

Boston, Sept. 24th, 1851.

EDWARD ALLISON, ESQ.,

Dear Sir:—I have the honor to present you with my Report on the coal and coal formation of Hillsboro', in the County of Albert, and Province of New Brunswick, containing the results of a series of chemical researches into the nature and properties of the coal, and a sketch of the geology of the district.

Owing to the numerous and complicated examinations I have been obliged to make, to render as perfect as possible our knowledge of the many and curious fossils, both of animals and vegetables, which characterize your coal, and the time required for the execution of the lithographic drawings, also that required for a series of chemical experiments necessary to fully prove the characters of the coal in comparison with a great number of other substances, I have been obliged to delay the preparation of this communication until now, and I trust that you will find that my labors have been successful in fully elucidating a subject that has embarrassed men highly distinguished in the walks of science, but whose opportunities seem not to have afforded them the means of arriving at correct conclusions with respect either to the geological age, position, or relations of this coal-bed, and who have, under erroneous impressions, attributed to the coal properties which it does not possess, but which belong to *coal-tar pitch* and *asphaltum*.

I shall be able to prove to the satisfaction of all scientific men, that the Albert coal is a true bed, included in bituminous shales of the true coal formation, as appears from the stratigraphic relations of the accompanying rocks, and from the nature of the numerous fossils, fishes and plants, characteristic of the coal formations of other countries and of this, and I shall demonstrate that the geological age of the coal is the same as that of the including shales, and that they are cöeval with the alternating gray sandstones of the same series, and that the rocks of the whole Albert coal-field are well-known members of the coal formation, as admitted elsewhere by learned and experienced geologists. I shall next show conclusively that the substance in question is really coal of an unusually bituminous richness, that it cannot be confounded with asphaltum, and will not serve for the uses to which that substance is applied; so that neither in a scientific or practical point of view is it any variety of asphaltum. It is true that, when first presented with a piece of this substance, with the intimation that it came from some place near St. John, which I knew was not situated in the coal formation, and under the impression that it was found

in a vertical fissure, in rocks of a more ancient date, I supposed it was some kind of altered bitumen, to which the term asphaltic coal might be applicable; but on examining the locality myself, I was immediately undeceived, and learned that it was really a bed of bituminous coal, in the regular coal formation. I also learned, by my own examination, that no such substance as soft asphaltum or maltha is found in the Albert coal, or anywhere near it, or in any rocks in the vicinity, and that the specimen sent by Dr. Abraham Gesner,* as I believe to mislead me, came from the soil of another county, and was the scum of an old petroleum spring, which I have since also visited and examined.

The first specimens of the Albert coal that came into my possession were analyzed by me on the 16th March, 1850. The specimen had a specific gravity of 1.107, water being 1.

The analyses were such as are required for commercial purposes, and gave the following results:—

	1st Analysis.	*2d Analysis.*
Bituminous matter convertible into gas, and removed by heat,	58.8	58.5
Coke,	41.2	41.5
	100.—	100.—

The coke, on incineration, yielded 0.47 per cent. of red brown ashes, consisting of peroxyd of iron, silica and a little oxyd of manganese.

A quantity of the coal in powder was digested in oil of turpentine, and a small portion of bituminous matter was dissolved by it, but so little as to give no encouragement to the project of employing it for a varnish, and therefore the weight of it was not determined, since my employers were satisfied that it would be of no account in any commercial point of view. Subsequently, as will appear further on, I did accurately ascertain the proportions of bituminous matter that can be extracted from this coal by all the usual and proper menstrua, and with all the appliances to obtain every trace of soluble matter contained in it. Some time after my analysis had been reported, in the spring of 1850, a cargo of the coal was brought to Boston, and samples of it were analyzed by my colleague, Dr. Augustus A. Hayes, of this city, who designated it as coal, and recommended it, as I had done, for the production of gas for illumination. (See his Analysis.) Early in April, 1851, I received a number of samples of this coal from Mr. George E. Cook, of New-York, with a request that I would analyze them, which I did, with the following results. The coal had a specific gravity of 1.09. It yielded, on two analyses, as follows:—

	1st Analysis.	*2d Analysis.*
Bituminous matter convertible into gas, and removed by heat,	61.67	62.
Coke,	38.33	38.
	100.—	100.—

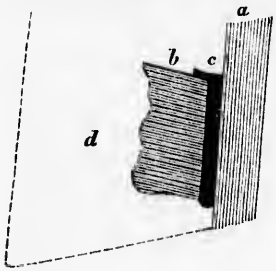
* See letter of Dr. Gesner to Dr. C. T. J., p. 29.

I was informed that some persons had raised a doubt as to the occurrence of this coal in the usual coal formation, and I therefore wrote a memorandum for the chief miner to send me specimens of the rocks, and to search particularly for fossil plants, and in due time I received, through the hands of Mr. Cook, some specimens of dark brown shale, in which I discovered a great abundance of scales of fishes, of the genus Palæoniscus, which I knew belonged to the coal formation, and were never found in any rocks below the coal group. Expressing my convictions at the time, that, if I should visit the mine, I had no doubt I could find entire fossil fishes, and thus obtain conclusive proofs as to the true geological age and position of the coal shales, I was employed to examine the mine, and o the 29th of April, in company with Messrs. Cook, Spurr and Anthony, I set out for the mine, and reached there on the 3d of May. On the 5th of May I went into the mine, and obtained a number of slabs of the shale, including the coal, and in presence of a large number of miners, and persons interested in the mine, I split open these rocks, and in the very first slab opened, I found an entire and perfect fossil fish, of the genus Palæoniscus. On splitting open the other rocks, I discovered three or four more fishes, and an abundance of fish coprolites, with the remains of putrid fishes and bunches of fish-scales. These discoveries, so new and astonishing, produced much excitement at the mine, and created an enthusiasm among the workmen to discover more of these curious relics of by-gone ages, and I soon after had the pleasure of receiving a larger fossil fish, from the chief miner, than had been found by me during my first visit to the mine. I observed some very curious markings in the shales, resembling the forms of rock weed, (*fucus vesiculosus*,) but not indentical with any fossil plants that I had seen; and on further search, at a subsequent visit, these markings were found to be the leaves of the Sphœrædra resembling one described by Lindley and Hutton, (Vol. iii., Pl. 159,) and also a specimen from Pictou coal mines, in possession of Mr. J. E. Teschemacher. They were found to be attached to branches from a stem, as represented in the annexed drawing, (Pl. III., Fig. 6.)

The weather proving unpropitious for a survey of the surrounding country, and the snow being still deep in the forests, I could only make my researches in the mine under ground, and there I sketched all the most important features of the bed, and its including rocks, and took the course of it and of the strata, both of which have a direction nearly north-east and south-west, with a dip at a high angle to the north-westward. Since all the observations I made on my first visit to the mine, were repeated by me in greater detail, and with greater exactitude, during my second visit, it will be unnecessary to detail those made at the first. I have before me the notes of all my surveys of the mine, and I find that the two agree in all essential particulars, but that the second set are the most exact, since the extended workings of the mine had opened better views of the strata, and disclosed the character of a few of the disturbed masses of rock, called "horses"—those broken strata which have led other geologists into such grave errors, by causing them to believe that they constituted the walls of a vein in a cross-fracture of the strata, an error which more exact researches have entirely corrected, and explained in perfect accordance with my own views concerning the position of the bed, and of the strata inclosing it.

My first visit to your mines, as before stated, was on the 3d of May, 1851, and I then remained until the 13th of that month, when I returned to Boston, and made report of my discoveries to the Boston Society of Natural History. On the 23d of May, I was again called to visit the mine, and met there Richard C. Taylor, Esq., and Professor J. Robb, who had, as I learned, been employed by an individual who had set up claims to the right of soil, and who maintained that the Albert coal was not in the coal formation, and was not coal or any mineral or fossil embraced within the crown reservations. By your instructions, these gentlemen were to be allowed every facility in satisfying themselves concerning the geological situation of the mine; but it was distinctly understood that I was not to be connected with them in any joint commission, although I was allowed to invite them to visit the mine in my company. Before reaching the mine, this was fully explained to those gentlemen, and I offered to give them any geological information concerning the mine, that was desired by them, and then we descended into it together, and made a few observations on the dip, direction and width of the coal-bed, and the inclination of the rocks including it, each party taking notes in their own books, as they saw fit. No other survey was made at that time, nor did I express any opinion beyond this, that it was obvious enough that the coal had been softened in place, and hence had assumed, on induration, a columnar structure. I steadily maintained that it was coal, and a regularly imbedded mass of the same geological age as the bituminous shales in which it is found. This opinion Messrs. Robb and Taylor endeavored in vain to change, by pointing out the masses of strata that were intercalated in the coal-bed, and insisting that the strata were discordant; while I, on the other hand, denied that these masses formed the walls, or belonged to the general stratification of the country. I knew that they were what the miners call "horses," and were masses of crushed and broken strata, that had broken off and pressed into the coal during its partially softened state, and at the epoch of its elevation. *This I subsequently proved by causing the miners to cut through them to the back walls, which were found most perfectly parallel with the coal-bed, and in accordance with the general stratification of the country.*

In one part of the mine, both Mr. Taylor and Professor Robb saw the back wall, behind one of these "horses," and took sketches of it. Mr. Taylor was not satisfied with Dr. Robb's sketch, and drew one himself, and I took a sketch of it, too, which is as follows:—



LEVEL 8.*

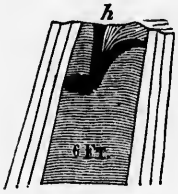
a. Wall rock; course N. 45° E., dip N. W. 70°.
b. "Horse," or crushed strata.
c. Coal seam.
d. Level from which coal had been extracted.

* For Survey of 8th Level, see p. 29

In another part of the mine, we examined a projecting mass of strata, called the "jog" and I made the following sketch of it:—

LEVEL 8.

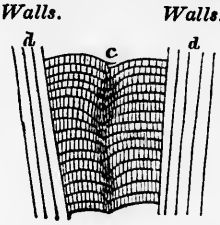
Dip 75°



h. "Horse," or mass of strata included in coal at the jog.

This is evidently a "shift" or "fault" in the strata, such as frequently occur in coal mines. (See also my survey, plan No. 2.)

At the place where the miners had just been extracting coal, in the end of the 9th level, the following diagram was sketched:—



9th LEVEL.

d. Shale including the coal.
c. Crushed coal.

7 feet 10 inches width of bed; underlie of strata on left 5°, or about 7 feet in 25 feet.

In the 4th level I took the following sketch:

Example of the remarkable contortions of the strata.

Level No. 4 at N. E. end.

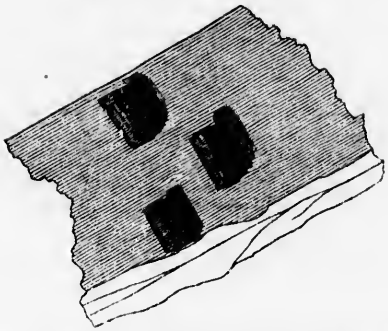
In level No. 6, we visited the blowers of fire damp, and ignited the bubbles as they broke through the water at the bottom of the level.

After making such observations as were deemed necessary, we came to directly opposite conclusions as to the geology of the mine, and the nature of the coal, and I considered it quite unnecessary for us to hold any further discussion on the subject, since I knew I could sustain my position before the scientific world, by means of documents from the hands of nature, that admitted of no dispute, namely, the fossils which characterize coal formations, and which are found in adequate numbers at this mine to afford all the evidence desired. Nevertheless, I omitted no examinations that were

required to fully confirm the evidence of the fossil fishes and plants that I had discovered. On exploring the strata along the margin of the brook, near the mine, I discovered several alternations of the gray sandstone, full of calamites and other usual coal plants, with the fish-bearing bituminous shales of the coal mine. These observations cut off the last ray of hope in the opposing party, of classing that sandstone with rocks below the coal series. I discovered also specimens of perfect stems of Lepidodendra, in the shales of the mines, associated in the same specimen with an abundance of Palæoniscus scales. Large flag-like leaves of plants, which are regarded as a species of Palm, were also found in the same shales, containing fish-scales. Stems of a fresh-water plant, not yet determined, were also found in the same shale with the fishes.* With these specimens in my hands, I felt perfectly sure of the geological age of this coal-bed. It has been alleged that the rocks of this coal mine belong to the old red sandstone, or to rocks below that system. Now, I confidently appeal to the scientific men of the whole world, and ask if they ever found Palæoniscus fishes, Lepidodendra and Palms in rocks so low in the series as even the old red sandstone, to say nothing of rocks lower in the scale. It is well known that *not one of the fossils found in the shales of the Albert coal mines, was ever seen in any rock below the regular coal formation*, and that no law of nature is more certain than the order in which fossil animals and plants are disposed in the earth's crust. Fishes, though proverbially dumb, are good witnesses in this case, and fossil plants stick to the truth proved by the fishes. I collected a great number of these most interesting specimens, and have now before me two large drawers full of fossil fishes and coal plants, collected at the Albert mine by myself and my friends. Already I have described six new species of the genus Palæoniscus, and have no doubt that I shall make out several more. I have before me, also, hundreds of specimens of shale, full of fish-scales, coprolites, and portions of fishes, more or less perfect. That portion of the strata containing fishes would naturally be less fertile in remains of plants; hence the latter are not so abundant: but I doubt not that further explorations which shall reach the shores of the ancient lake in which these fishes originally lived, will disclose a vast abundance of plants that must have grown on its margin, and fringed its shores. The sandstone, a few rods up the little stream that runs by the mine, is doubtless the sandy shore of that ancient lake, and when opened by the miners' blast, will be found richly stored with plants, forming a *hortus siccus*, or Herbarium of olden time. This state of things is realized on searching the strata to the eastward of the mine; and also in the rocks of the Cape near Demoiselle Creek, on the shores of the Petitcodiac River, so strangely mistaken for old red sandstone, which are the gray sandstones of the regular coal-field, they being full of the usual coal plants and large fossil trees, three of which are seen projecting out from the inaccessible part of the cliff, some fifty or sixty feet overhead, as roughly sketched in the following diagram.

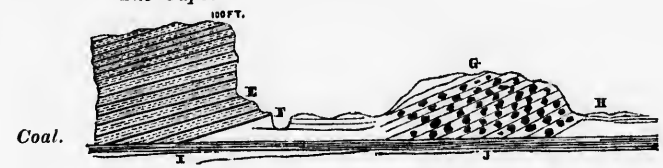
* Since the above was in press, I have seen a stigmaria, found in the shale at the Albert mines, by Mr. Robert Foulis.—C. T. J.

Dip South 10° *to* 15°.



The sandstone fossil plants and trees are identical with those found at the well-known coal mine of the South Joggins, on the opposite shore of Nova Scotia. At Demoiselle Cape, on the Peticodiac, I found a narrow bed of coal at the base of the cliff, with stems of calamites two feet long by two and a-half inches in diameter. The sandstone is full of the usual coal plants; so there can be no doubt as to its geological age and position in the series. The general dip of the strata is to the south, a little westward, at angles of from 10° to 15° from the horizon. This locality is east from the coal mine, and hence the sandstone is of the same series with the beds on the Western side.

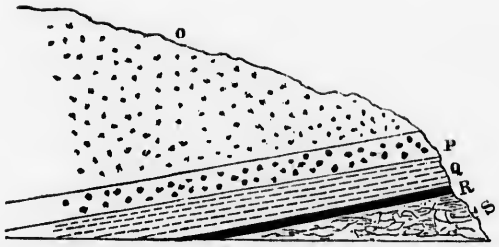
The Cape.



E.—Red Marl.
F.—Demoiselle Creek.
G.—Edgett's Cape.
H.—Edgett's.
I.—Gray Sandstone.
J.—Conglomerate.

The strata at Edgett's Cape consist of coarse conglomerate rocks made up of pebbles of quartz, metamorphic slate, or novaculite, sienite, epidote rock, serpentine and slate, cemented by a red clay, with spots of green marl. No fossils were found in this cliff.

The next cliff to the south of Edgett's is near Demoiselle Creek, and consists of gray and brown sandstone, or grits of the coal measures, full of calamites and other coal plants, and contains three large fossil trees, and has at the base small beds, or seams of coal. The strata dip to the south, a little westward, from 10° to 15°. The conglomerate strata at Edgett's pass beneath this sandstone. It is proved that this gray sandstone, full of the usual coal plants, belongs to the regular coal series, and is the equivalent of the same kind of sandstone which includes the shales and coals of the South Joggins of Nova Scotia. We come next to compare the gray sandstones of Curry's brook with this rock, and find it as follows :—



O.—Gray Sandstone.
P.—Upper Conglomerate.
Q.—Brown Bituminous Shale.
R.—Coal
S.—Fire Clay.

The strata dip to the south-eastward. By comparison with the following section of Demoiselle Cape, it will be seen that there is a conglomerate rock also below the gray grit.

Dip 10° *to* 15° *S. W.*

L.—Fine gray Grit—Fossil Trees.
M.—Coarse brown Grit.
N.—Fine blue Sandstone.
O.—Coal.
P.—Under Conglomerate.
Q.—Peticodiac River.

It is also important to show the geological position of the gypsum of this coal-field, and by the aid of my friend, Mr. Foulis, I was enabled to trace, in a rapid manner, the order of succession of the rocks with which it is associated, his familiarity with the ground, rendering him an invaluable geological guide. On visiting Taylor's mill site, on a small stream, a little to the north of east from the Albert mines, we found the rocks upon which the gypsum rests, as represented in the following diagram.

T.—Coarse Conglomerate.
U.—Gray Limestone.
V.—Gypsum.
W.—Red Marl.
X.—White Head, snowy white Gypsum Hills.

In the bed of the brook, and on the side of it, occurs a coarse conglomerate, made up of pebbles of quartz, sienite, green metamorphic slate, trap-rock, jasper and carbonate of lime. On this, reposes a bed of gray limestone, in which we did not discover any fossils, but which is seen to rest directly on the conglomerate, with which it dips 10° regularly to the westward, or towards the gypsum, which is found a quarter of a mile further west It is obvious, therefore, that the gypsum rests upon the limestone, and the limestone upon the conglomerate, which is a member of the coal group. The whitehead gypsum, is about a mile south-west from Taylor's mill, and is a bold cliff, presenting a mural escarpment of thirty feet in height, where it is quarried. This gypsum is of a pure snowy whiteness, and is destitute of any stratiform structure, and contains no fossils.

In company with Mr. Foulis, I explored the margin of this curiously crushed coal basin, examining, at every practicable point, the rocks, as they were exposed in the beds of streams, or on the hill sides. We searched the bed of Milton's brook, where we found bituminous gray sandstone, which dips gently to the south-eastward, at an angle of about 10°. Over this gray sandstone, is another thin stratum of black shale. We came next to an opening, made by Mr. Foulis, in search of coal, and observed the bubbles of light carbureted hydrogen, or fire-damp, that burst through the water. Following the brook towards a small lake, on Mr. Allison's south-west lease, we came to coarse conglomerate, in the bed of the brook, and on the hill. It dips 20° to the northward. This spot is one and three-fourth miles south of the Albert mine.

Crossing through the woods, about a mile and a-half, we came to a hill of blue slate, much indurated and highly inclined, the dip being 40° to the northward. Crossing again through the woods to the eastward, we came to a ravine, filled with immense blocks of sienite and old greenstone, with large slabs of green hone slate. The novaculite, or hone slate, was soon discovered in place, and found to have a dip to the northward at an angle of 35° or 40°. This altered slate rock, is remarkable for its distinct cleavages into rhombic prisms, with angles of 70° and 130°, and 80° and 120°. We traced the strata of this rock towards the sienite, until it was found to have the bold dip of 70° to the northward. Mr. Foulis had previously explored the sienite rock, on the borders of the lake, and there cannot be a doubt that the elevation of that igneous rock, produced the high dip of the metamorphic slates which border the coal basin, and it is probable that the slate was indurated by the influence of the molten sienite rocks, at the epoch of their elevation. The coal basin, however, was probably filled with its

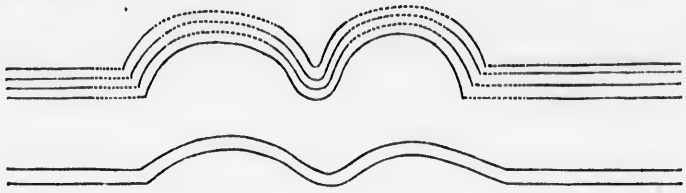
sedimentary deposits, after the original elevation of this rock; but still there may have been considerable movement in the masses since these curious metamorphoses took place, for we have no proof of the eruption of any sienite rocks subsequent to the coal formation. It is evident that this is the southern margin of the coal basin. On searching for the northern margin on Caledonia mountain, thirteen miles west of the mines, we found that the rocks at that place did not belong to the Albert coal basin, but dipped to the northward, away from it, and hence were of no importance in this case. Metamorphic slates, similar to those I have been describing as occurring near the lake, south of the Albert mine, are also found in the Caledonia mountain, and had been examined some days before I went there, by Mr. Taylor. We found the places where he had broken off his specimens, and made his observations. The strata, all the way from Beasly's and Stevens' farms to the top of the mountain, dip to the northward at a high angle, and therefore belong to a more northerly basin. It is therefore unnecessary to describe the locality in more detail, for the strata have no connection with the Albert coal mine.

The following diagram will explain the relative positions of the igneous, metamorphic and carboniferous rocks of this district.

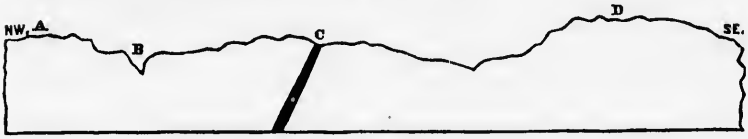
1. Sienite and old greenstone, at Foulis' Lake.
2. Novaculite, metamorphic slate, near lake.
3. Conglomerate (lower) on hill, near lake.
4. Gray sandstone, or freestone, quarried.
5. Conglomerate, (upper,) } Taylor's Brook, at the mill.
6. Gray limestone, }
7. Gypsum, (white head.)
8. Gray sandstone, full of calamites, brook near Albert mine.
9. Bituminous shales with coal, fossil plants and fishes in abundance.
10. Gray sandstone, with calamites, &c.
11. Coal shales, with fish scales, &c., brook, near Albert mine.

This system is mostly seen on the south-east side of the basin; the other side is not yet explored in sufficient detail to be given. I have designated the position of the gypsum on the south-east, as it was determined by observation, on the north-west side it was not sufficiently explored to determine, with accuracy, on the Fuller lease, and at Milton's, on the southerly side of the basin. Its positions there are shown on the accompanying map, furnished by Mr. Foulis. The gypsum is evidently one of the carboniferous group of rocks. In this opinion I am sustained by that of Sir Charles Lyell, Mons. Jules Marcou, traveling geologist to the Museum of the Garden of Plants, at Paris, and by the observations of Mr. Dawson in Nova Scotia. The position of all the rocks given in the above diagram, is known from actual observations made by Mr. R Foulis

and myself. I do not undertake to give any representation of the disturbed strata at the crush in the mine, knowing that it would be quite impossible, without a complete book of drawings, to show all the dislocations in so disturbed a spot; but I can show how geologists have been deceived by curved strata, the edges of which came in contact with the coal in a few spots, thus:



The continuous lines represent the strata actually seen to be curved as seen in the mine. The dotted lines are their undoubted continuations beyond where they were seen. They are a mere crimping or curving of the strata, a very common appearance in well-known coal mines. Sometimes portions of strata were forced out of place, directly into the coal-bed, and form those masses called by the miners "horses," worthless rocks in the coal. These are seen in several places in this mine, and one is represented in a preceding diagram. The position of the mass of shale, with relation to the neighboring gray sandstone on the south-east of the mine, is thus represented from the results of the observations of Dr. James G. Percival, Mr. R. Foulis, and myself.



A.—Gray Sandstone.
B.—Brook.
C.—Mine.
D.—Gray Sandstone with calamites, &c.

The gray sandstone dips southerly, from the Petitcodiac River to the mill east of the mine. On the brook, near the mine, the strata of shale alternate with the sandstone, and the former are full of fish-scales, and the latter full of calamites and other coal plants. These alternations prove that the sandstones and shales are of the same geological epoch, and that they all belong to the coal formation.

By examination of the accompanying geological map, the relations of the rocks of this interesting district, will be more fully understood than by any single sectional profile. It has been prepared from careful and extensive observations made by Mr. R. Foulis and myself, and derives most of its value from the well-known and laborious researches which Mr. Foulis made during nearly two years past, while he was engaged in searching for coal on neighboring estates. In expressing my obligations to this scientific gentleman, I perform but a simple act of justice to one whose geological labors have done so much in bringing to light the valuable minerals of this province.

PHYSICAL AND CHEMICAL CHARACTERS OF THE ALBERT COAL.

The coal of the Albert county mine has been stated to be entirely uniform, and an argument in favor of its being asphaltum has been based upon this assumption. That it is not uniform in density is well known to those who have purchased it, and the results of my experiments in the coal taken from different levels of the mine, prove indisputably that there is a great difference in its density, as may be seen in the following table of specific gravities of the different specimens:

No. 1.	Surface in Duffy's slope, sp. gr.	1.1120—water being 1.
2.	" " " " "	1.1140
3.	" " " " "	1.1014
4.	" " " " "	1.1023
5.	Level No. 6 " "	1.1057
6.	" No. 9 " "	1.1093
7.	" No. 8 " "	1.1040
8.	" " " "	1.0990
9.	" No. 9 " "	1.0950
10.	" " " "	1.0905
11.	" No. 2 " "	1.0886
12.	" " " "	1.0890
13.	Bottom of Duffy's slope " "	1.0916

Trinidad asphaltum has a specific gravity of 1.328. Asphaltum from Egypt, sp. gr. 1.142.* Hence a low specific gravity cannot be adduced in favor of the identity of the Albert coal with asphaltum. The powder of Albert coal is jet black: that of asphaltum is snuff brown. Asphaltum melts and runs when heated—Albert coal *does not melt* and run.

CHEMICAL EXPERIMENTS.

The following experiments were made on the Albert coal, the specimens being taken from Level 8. Sixty grains of the coal, treated in fine powder, with a fluid ounce of naphtha, and corked up tight, and shaken several times per day. At the end of some days it was filtered on weighed filter, dry, at 212°, and left of undissolved coal 56.5 grains; hence 3.5 grains was dissolved by the naphtha, or 5.83 per cent. was soluble, and 94.17 insoluble. The 56.5 grains which naphtha would not dissolve, was washed with pure ether, and then digested in highly rectified oil of turpentine in a flask, loosely corked and boiled. It was then filtered on a weighed filter, dried at 212°. It weighed 48.5 grains—hence 8 grains had been dissolved out of it, or 14 per cent., and 80.17 per cent. of coal, perfectly insoluble in all menstrua, remained.

A specimen from the 9th Level was pulverized, and 10 grains of it weighed and digested in pure benzole, so long as any matter could be dis-

* Boghead coal, from Scotland, has a specific gravity of 1.155.—*Journal of Gas Lighting, Jan* 10, 1851.

solved out of it. It was then filtered on a weighed filter, dried at 212°, washed thoroughly with benzole and ether, and dried again at 212°. It had lost two grains of soluble bitumen, or 20 per cent. The remaining 80 per cent. of coal was perfectly insoluble in all the solvents that would dissolve bitumen.

Samples of several varieties of the Albert coal were acted upon by pure chloroform, which dissolves about as much of it as benzole does.

These experiments were repeated several times with the same results. The bitumen dissolved out by oil of turpentine was found to be perfectly insoluble in alcohol, and was not any kind of resin. It dries and forms a pellicle on the dish from which the oil of turpentine is evaporated, and alcohol will not remove it, even when aided by heat.

Specimens of asphaltum from the Dead Sea, and chapapote, from Cuba, were found to be instantly and entirely soluble in cold benzole, chloroform, and warm oil of turpentine. Asphaltum, from Trinidad, also immediately dissolves, and leaves nothing but a little gravel, with which it was mixed,

The Albert coal was compared with all the varieties of asphaltum above-mentioned, and with some specimens from Egypt, furnished me by Mr. Teschemacher, and no analogy was found between them in any of their chemical characters.

All the specimens of asphaltum melt readily at a heat a little above that of boiling water, while the Albert coal does not melt, even in molten zinc, at 700° F., and is not in the least affected by the heat of melted tin, a solid tin dish filled with it melting readily, without the coal being in the slightest degree softened.

So, likewise, a thick lead cup, filled with the Albert coal, was slowly heated to the melting point, and melted, without in any way softening the coal. Every advantage was afforded to enable the heat to melt the coal at 612°, but no change took place in it. Specimens from all parts of the mine were tried, but not one could be found that would [illegible] at the above-named temperature.

I next made an experiment suggested by Mr. James E. Teschemacher, of this city, taking the Albert coal in fine powder, and covering a sheet of platinum with it, and placing it over a Berzelius spirit-lamp, and heating it as quickly as possible, to see if it could be melted at all. It was found that it could not be melted, and did not even agglutinate or cake, but when sufficiently heated was converted into coke, taking fire as the heat reached redness.

On making the same experiment with every kind of asphaltum which I had in my cabinet, and on all kinds that could be obtained, they, without a single exception, when heated as the Albert coal had been, at once ran into a liquid mass, boiled and decomposed, leaving little carbon on the platinum.

I also tried by every means in my power to melt the Albert coal in a ladle, and in crucibles, so as to pour it out, as had been alleged could be done, and in no case was I able to melt it; while on the other hand all kinds of asphaltum were readily melted in, and poured out from the ladle, like molten pitch, and when cold the asphaltum was found but little changed in character, being only a little porous from air bubbles.

I brought home some of the coal-tar pitch, which was so abundantly scattered about Hillsboro' by Mr. Edgett and his associates, and found that

it softened readily in boiling water, and could be melted in a flame and used for sealing wax. It melted and ran when placed in the flame of a lamp, was decomposed at the temperature of melting tin, and corresponded so well, in all its characters, with the description given in Mr. Taylor's report to the substance he describes as asphaltum, that I could not avoid believing that some one had changed Mr. Taylor's specimens, for not one of the pieces of Albert coal which I took out of the mine and gave him has any of those properties.

From careful examinations, with every possible advantage for arriving at truth, I cannot find any reason to regard the Albert coal as any variety of asphaltum.

TABULAR STATEMENT.

We come now to tabulate the geological evidence that the Albert coal is in the regular coal formation, and not in the old red sandstone, nor below it.

1st. The rocks in which this coal occurs, are the gray sandstone, like that which includes the coal and coal shales of Nova Scotia.

2d. That these sandstones contain the usual plants that characterize coal-grits.

3d. That these sandstones alternate with the coal-bearing shales of the mine.

4th. That the shales immediately including the coal contain the usual plants found in other well-known coal mines, viz., Lepidodendra, Palm-like leaves and stigmaria.

5th. That these shales are filled with the scales of fishes, and contain, also, perfect fishes of the genera known to occur in the coal formation of Europe.

6th. That the shales are uniformly bituminous throughout the coal district of this mine, and must have been formed at the same time, and of the same materials usual in coal deposits, and could not, by any possible means, have been impregnated so generally and uniformly with bitumen, if they were formed before the epoch of the formation of the bituminous matter of the coal itself.

7th. That such bitumen was the result of spontaneous changes of vegetable matter in the mud or clay that formed the shales, it having been proved by the observations and researches of Dr. James G. Percival and myself, that such bitumens do form under water in clay and mud, even in modern times.

8th. That there is no other known origin of bituminous matter than that of changes in vegetable substances, by the process before alluded to, viz., the alteration of vegetable matter under water.

9th. That clay, by holding water long stagnant, peculiarly favors the conversion of vegetable matters into bitumen.

10th. That the shales, when deposited, must, in accordance with the laws of gravitation, have been deposited horizontally or nearly so, and that they since have been uptilted at the Albert mine, and are now set at a

highly inclined angle with the horizon, but are generally parallel with the included bed of coal. This is proved by the position of the fossils.

11th. That the general direction of the strata which include the coal is north-east and south-west, exactly parallel with the contiguous strata. This is also shown by Mr. R. C. Taylor's map of the mine, and is proved by an actual survey made by myself, with the assistance of Mr. Brown, the captain of the mine. (See the plan.)

12th. That there is not any reason to believe that any igneous agency was ever exerted upon the rocks of this mine; but, on the contrary, their soft clay-like nature, the abundance of volatile matters, bitumen, and ammoniacal salts which they contain, positively prove that they have never been exposed to igneous agency, such as would result from volcanic or plutonic disturbances.

That the Coal is a true bed or mass included between strata of rocks before proved to belong to the Coal formation, and has the structure of Coal.

1st. By its being a bed running in the *same direction* with the *including strata.*

2d. By its being generally parallel with the laminæ of deposit of the strata, as shown not only by the structure and cleavages of the shales, and by the position of the fossils that were deposited between the layers of sediment forming the rock.

3d. By the structure of the coal itself, which shows layers of different shades of color, and different composition or arrangement, that the now highly inclined or nearly vertical bed was once horizontal, and exactly parallel with the strata of the rock at the time that they were deposited. I do not refer to the columnar structure which has resulted from changes which the bed has undergone since it was tilted up, nor to the crushed coal which has been broken by movements since the coal became brittle; but to the solid coal itself, which, on being viewed, shows lines of structure crossing the columns nearly perpendicularly, and to the fact that the coal in many places separates parallel to that structural arrangement, especially where it has been exposed to the action of the atmosphere, as in Duffy's slope, near the surface of the earth.

Mr. Teschemacher thinks he is able also to detect the remains of organic structure in the coal itself, as he has so successfully done with respect to anthracite, and other coals, the vegetable origin of which was also at one time denied or doubted, as that of this coal recently has been by the Geologists employed by the party adverse to your claims. In some specimens we think there are pretty distinct remains of the structure of stigmaria in that portion of the coal which was sustained, while in its original pulpy state, by the clay that now forms the shale roof and floor of the mine.

The conchoidal fracture of the Albert coal, which is often referred to to prove it is not a coal, is merely the result of the perfect fineness of the pulpy vegetable matter that formed it.

It is probable that the highly bituminous character of the Albert coal is owing to its never having been subjected to heat, which would have removed a portion of the bitumen, if it had acted on it, and would have rendered it less bituminous, like the ordinary bituminous or semi-bituminous coals.

Conchoidal fracture is common to many coals, and is obvious even in the recent coal formed by the spontaneous bituminization of peat. It is not in any way a reliable character, but is a mere accidental result, or the result of fine composition and structure. I would also observe that the color of the powder of this coal is black, while that of all varieties of asphaltum is brown, or nearly the color of Scotch snuff. This is a physical character admitted by mineralogists in the description of mineral bodies, and is characteristic of species much more certainly than the color of masses.

Fossil Fishes of the Coal formation found in the Coal Mine of Hillsboro', in Albert County, in the Province of New Brunswick.

It is generally conceded by experienced geologists that the character of the organic remains found included between the strata of such rocks as were formed since the earth was inhabited by living beings, is the most reliable evidence of their geological age, and best determines their position in the scale of rock formations. Eminent naturalists have been able, not unfrequently, to discover the true age and geological position of a rock, which they had never seen in place, simply by the examination of a few fossils which were put into their hands. These fossil remains of animals and vegetables are the great seals by which the CREATOR stamped the epoch of formation, and the relative age of every sedimentary deposit at the time it was made, thus writing, in unmistakeable characters, on these "tables of stone," the history of Creation from the dawn of organic life.

We approach these relics of by-gone ages with mingled feelings of curiosity and awe, knowing that they are the work of CREATIVE WISDOM, and types of that order of beings which was the first introduction of vertebrate animals, a system of which man is the completion and perfect development.

The world, during the epoch of the coal formation, was far from being a desolate waste of mere mineral matter. Life had already clothed the earth with rich foliage, and crowded the waters and the groves with sportive animals, endowed with organs of sensation of much higher and more delicate powers of perception than were possessed by those of a more ancient date, for the nervous sensorium of the animal creation has steadily advanced in process of development from the earlier organisms of the more ancient palæozoic rocks to the coal period, and from thence forward, with rapidly increasing perfection, to the actual epoch, or the time of man's creation.

The world, we may feel assured, swarmed with life during the coal period, for otherwise we should not discover in the few "tables of stone," broken open by the feeble labors of man, such a profusion of their entombed remains. We may not be able to penetrate at once into all the laws which brought about this wonderful conservation of relics of former life, nor be able to picture in the mind the precise manner in which each fossil animal came to his death, nor learn exactly by what means he was buried, embalmed or petrified; but we have already learned much, and should be thankful for that, without lamenting that we are not able to tear asunder the veil of creation, and to gaze upon its whole internal machinery, and learn all the details. So far as the researches of man have gone, in the

examination of fossils of the coal formation, everything seems to indicate that climate temperatures did not at that epoch depend solely upon the solar radiation, or if they did, the earth must have had a very different position in the ecliptic from that which it now has. Otherwise we should not find remains of intertropical plants in the rock formations constituting the coal-bearing strata of the Frozen Zone, as in Melville's Island. Nor should we find such orders of plants in the coal-fields of Cape Breton, Nova Scotia and New Brunswick.

The fossil plants of the coal formation all belong to extinct species, and their nature is known only by comparison with living plants. Vast progress in this most interesting department of science has been already made, as is proved by the ponderous volumes, full of descriptions and plates of the ancient fossil flora, which have resulted from the labors of Brongniart, Lindley & Hutton, Baron Sternberg, and others.

Invertebrated and molluscous animals, especially such as had testaceous coverings, are most abundant in rocks below the coal formation, and some of them are found alternating with deposits of aquatic vegetation of the coal-field. But the most important type of vertebrate animals, such as fishes, are extremely rare in rocks antecedent to coal, though the labors of Hugh Miller and others have laid before the world, in their works and those of M. Agassiz, a number of the strange fishes of the old red sandstone group in Europe, proving that the type of fishes began in rocks anterior to the coal, while not a single species found in the old red sandstone occurs in the coal rocks of any country.

I shall have occasion to show, as we proceed, that there is not any difficulty in distinguishing fishes of the coal formation from those of the old red sandstone, and that any intelligent person who has spent a few days in examining specimens, can pick out, with absolute certainty, every fish that belongs to the coal formation, from a cabinet filled with heterogeneous assemblage of fishes of the old red sandstone, and of the coal formation. Our lithographer, M. Sonrel, who executed M. Agassiz's plates of fishes of the old red sandstone, on viewing my fishes from Hillsboro', declared that there was not a species among them belonging to the old red sandstone, and wondered that any one could have mistaken them for fishes of that epoch.

It is said that an entire fish, not then discovered, was delineated correctly by Agassiz, from an attentive examination of a single scale, and the fish subsequently discovered agreed, in all essential particulars, with that sketched in advance of its discovery. This, at first, seems a very difficult thing to do, but after a few weeks' study of fossil fishes, I will venture to say, that any ingenious person can do it, without any instructor; for the laws of organization of fishes of this ancient type are peculiar, especially in the formation of their scales, which are so characteristic as to afford all the data required for the reconstruction of the outlines of a fish, even from a single scale. This is particularly easy with regard to ganoid fishes, of the genus Palæoniscus; their broad, firm and brilliant scales, like plated mail, being found perfectly preserved with every striation, serration, and articulating process.* It

* It is not my intention to diminish in any way the credit due to Mr. Agassiz for this experiment, but on the contrary to give it credibility among those who have not a just appreciation of the unerring laws of scientific induction. Like the egg experiment of Columbus, it is easy enough to repeat after one has been shown how to do it.

would be necessary, however, that particular scales should be obtained, in order to determine the relative dimensions of the fish, those near the lateral median line being the most characteristic. The dorsal and caudal scales are very different in their forms, and would puzzle any one, however skilled, to draw the outlines of an unknown species from them.

Fortunately, we have not been reduced to any such doubtful expedients; for the discovery of entire fishes, indicated by my first discovery of a few scattered scales in a fragment of rock, removed all difficulties, and confirmed the prediction most perfectly, the fishes being found to be of the kind indicated by the scattered scales.

It may be interesting to know the exact history of these discoveries, and therefore I copy from my notes the following details:—

On receiving a piece of shale, sent to me by the superintendent of the Albert coal mine, on the 11th of April, 1851, I recognized, in a moment, the little black and shining rhomboidal scales, with one margin serrated, and having fine striæ on their surface, as the scales of ganoid fishes, of the genus Palæoniscus. I discovered also, in the same specimen, a tooth of a sauroid fish, of which no other remains or impressions have yet been found. This specimen was exhibited at the time to the members of the Boston Society of Natural History, and the prediction was hazarded, that on visiting the mine I should discover entire fishes of the order mentioned.

On the 29th of that month, I was invited by gentlemen interested in the mine to visit it, and to make such explorations as were needful, to ascertain its geological age and position, and I accepted with pleasure the opportunity of searching this new field of scientific treasures.

On the 5th of May, I obtained a slab of shale from the 8th level of the mine, which, upon being split open, disclosed an entire fish most beautifully preserved with its shining armor. It was an entire and perfect Palæoniscus, with its head, fins, and tail well preserved, and its scales shining with silvery brilliancy, though of a delicate brown color. It is a regularly embalmed, not petrified fish. (See Pl. I., Fig. 1, *Palæoniscus Alberti.*)

The next splitting of the slab gave two or three other specimens of the same species, but they were broken in getting them out, and were taken away in fragments. The other slabs furnished a few more broken fishes, and a great number of decayed ones with scattered scales. Numerous patches of fish scales were also found, the mode of aggregation of which I did not understand until, on showing the specimens to Dr. Gould, he suggested that they might be the stomachs of decayed fishes, which, I have no doubt, is the true explanation.

I discovered also a great abundance of the excrements of fishes embalmed in bituminous matter, and containing undigested scales of fishes. These are called fish coprolites, and, on analysis, I proved them to consist mainly of phosphates of lime and magnesia, and to be really the excrementitious matter discharged by piscivorous fishes, and to be made up mostly from the mineral matters derived from Palæoniscus scales, which I have also analyzed. The animal matter is found both in the scales and in the coprolites embalmed by the bitumen, which so richly impregnates all the shales of this mine. The shales themselves are full of the ammoniacal salts, and on laying a slab of the rock on the fire, and afterwards splitting

it open, patches of carbonate of ammonia were found condensed in the cooler portion of the rock. This was proved, by tests, to be carbonate of ammonia.

Numerous aquatic plants, of the genus Sphœrædra, were found associated with the fishes and fish-scales, but no other perfect coal plants were found in the shale during my first visit to the mine; the stormy weather and snow preventing deliberate search.

On the 13th of May, I returned to Boston, and exhibited the fossil fishes to the Boston Society of Natural History on the 21st of that month, and described the species so far as I had examined them.

On the 23d of May, I was again employed to visit the mine, for the purpose of making a more complete survey than the weather would permit on my former visit, and also for the purpose of explaining to two geologists, who had been sent there by a person setting up claims to the mine, under pretence that the coal was not in the coal formation, and was not coal, but asphaltum, which he was understood to allege was not one of the minerals reserved by the crown, but appertained to the soil.

On the 26th of May, I reached Hillsboro' and completed my survey before the 8th of June, collecting a large number of fossil fishes and coal plants at the Albert mines, and returned to Boston on the 12th of June.

The miners, since my first visit, had learned how to find the fossil fishes, and Mr. Brown, the captain of the mine, discovered the finest specimen that has yet been seen, and he presented it to me. (See Pl. I., Fig. 2, *Palæoniscus Brownii.)* Another beautiful specimen was dissected out by Mr. Barber, one of the assistants of the superintendent. This is represented in Pl. I., Fig. 3. Another very large species was discovered by me, after my return home, on splitting open one of the slabs of shale. This is represented in Pl. I., Fig. 4. It is the largest that has yet been found.

Pl. II., Fig. 1, represents a portion of a beautifully preserved Palæoniscus, having the four great dorsal scales anterior to the dorsal fin, like the *P. decorus* of Sir Philip M. de Egerton. (See Trans. Geol. Soc., Lond., 1849.)

Figures 3 and 3 bis., represent a very pretty Palæoniscus, much contorted, as if it had struggled to clear itself of the mud, when imbedded. It is compressed so as to represent the back, and the gill plates are pressed open. The head is pointed as would result from vertical compression of the fish. This individual must have lain upon the muddy bottom of the lake, with its back or abdomen up, for such the position of the strata proves.

Figure 4 is a perfect fish, discovered in my presence by Mr. Wallace, deputy collector of the port, and the head is pointed as in that specimen. A coprolite is seen apparently under it, protruding along the upper side of the curved fish.

Fig. 7 is a Palæoniscus' lower jaw, containing the whole set of teeth, *placed in a line firmly fixed in the jaw*, like those of a salmon. These fishes I shall now describe more minutely; and if my descriptions are imperfect, M. Sonrel's beautiful lithographic drawings will supply any omissions that I may make.

DESCRIPTIONS OF THE FOSSIL FISHES OF THE ALBERT COAL MINE.

Pl. I., Fig. 1. This fish is the first one that was discovered by me at the Albert mine.

DESCRIPTION.—Fish, four diameters of its body long; head, obtuse or blunt, as if obliquely compressed on upper and front part; whole length, 3 3-10 inches; width, in middle of body, 85-100 inch; *fins*, one dorsal, opposite anal, small triangular, 3-10ths of an inch at base, jointed, drooping, as if the fish was dead before it was inclosed in the mud, (now shale). *Anal*, small, triangular, a little larger than dorsal; *Pectoral*, small, compressed into mass of scales of body of the fish; *Tail*, bifurcated, unequal, very long, and tapering in upper division, which extends to a fine point. The *scales* run down on upper division of tail, and become gradually smaller to tip; *caudal rays* come exclusively from under side of upper, and from lower division of tail. Scales of body brilliant, rhomboidal, wavy, serrated on posterior margins, color light-brown. This fish is embalmed and not petrified. No ridge of bone is seen to indicate the vertebral column, hence the bones must have been cartilaginous and compressible. The gill plates are too confusedly compressed to be dissected. I cannot find in any published book any figure of a fossil fish identical with this. It is evidently a Palæoniscus, and is probably a young individual, as seems to be indicated by its small size, and the delicacy of its scales. We will name it, provisionally, *Palæoniscus Alberti*, in commemoration of its being the first fossil fish discovered in Albert county, in New Brunswick.

Pl. I., Fig. 2. This beautiful fish was found by Mr. Brown, the captain of the mine, subsequent to my first visit to Hillsboro'. It is one of the largest, or full-grown species. It was unfortunately broken in the operation of extracting it, but it still is a very valuable specimen. This being the first fossil fish found by the chief miner, I have named it *Palæoniscus Brownii*.

DESCRIPTION.—Fish nearly whole. It is one of the largest species yet found, and its length is three times the greatest width of its body; whole length, 5 3-10th inches; breadth, 1 7-10th inches; head broken off just in front of pectoral fin; extremity of tail broken; abdominal fin missing, it having been broken in getting out the specimen. Dorsal fin, a little behind middle of body, opposite, or rather a little in front of anal.

Pl. I., Fig. 3, represents a perfect fish of the genus Palæoniscus which was found on the 3d of June last. In its general form and appearance it resembles the *Palæoniscus Elegans* of Prof. Sedgewick, (Lond. Geol. Trans., 2d series, Vol. iii. Pl. 9, Fig 1,) and Agassiz, (Recherches sur les Poissons Fossiles, Vol. ii., Tab. 10., Fig. 5,) but it differs from that species in the striation of the scales, the striæ of the Hillsboro' species being parallel to the anterior and lower margins of the scales, and the shape of the scales differing essentially from Mr. Sedgewick's species.

DESCRIPTION.—Fish, long and slender, 4 1-2 diameters of its body long; length of head, a little less than the largest diameter of the body; the head has the shape of an equilateral spherical triangle; tip of nose, or

snout curiously tuberculated and dotted; gill plates cannot be dissected, they are so brittle and confused with the head; *fins*, pectoral a little behind gill plates, and extend below the fish 3-10ths of an inch,—it is a narrow-pointed fin, well marked with its rays. *Dorsal fin* far back towards the tail, a little anterior to anal; it is half an inch long and 2-10ths of an inch high, and is well marked with its rays. *Anal fin* somewhat larger than dorsal, a little posterior to it. *Abdominal fin* very small, situated a very little in advance of the middle of the body; tail unequally bifurcated or heterocercal; *scales* run down on it becoming smaller and more and more acutely rhomboidal or lozenge shaped as they recede; caudal rays come exclusively from under side of upper division of tail. *Scales* obtusely rhomboidal on anterior and middle of body, and are distinctly striated parallel to anterior and lower margins, while they are smooth and very brilliant towards and upon the tail; dorsal scales large and in form of obtuse spherical triangles pointing backwards towards the dorsal fin. This species is not described in any book I have examined, and believing it to be new, I shall take the liberty of naming it *Palæoniscus Cairnsii*, after the highly intelligent superintendent of the Albert coal mine, William Cairns, to whose active and unremitting labors I am indebted for so many specimens of these interesting fossils.

Pl. I., Fig. 4. This large and elegant fish was most unfortunately broken in splitting it out from the rock, only the posterior part of it having been saved in a fit condition for delineation. The whole length of the fish was originally fifteen inches. That portion which remains entire is 5 1-2 inches long; it was broken off through the posterior edge of the dorsal fin. It was an old fish, as is evident from the appearance of the scales which are thick, heavy, and have their striations in part obliterated, while the serrations are extremely sharp and deep. The scales are elongated rhomboids, and have many striæ upon their surface which run parallel with their upper and lower margins. Caudal scales, acute lozenges. They run down on upper division which is long and covered with scales. Rays of tail come off very distinctly, exclusively from under side of the upper division, and the tail is unequal or heterocercal. Until we obtain an entire specimen, perhaps it will be prudent to abstain from giving a specific name. It is a species of the genus Palæoniscus.

Pl. II., Fig. 1. This species so nearly resembles the *Palæoniscus decorus* of Sir Philip M. de Egerton, as on first view to pass for it; but on examining the lines of striæ, we are forced to regard it as another species. The four great dorsal scales, anterior to the dorsal fin, exactly resemble in form those represented in Sir Philip M. de Egerton's plate. (See Quarterly Journal Geological Society of London, for 1849.) The scales of one specimen are striated, parallel with the superior and inferior margins, and are deeply and acutely serrated on their posterior edges. The lines of striation are worn away considerably, indicating, perhaps, that it was an old fish. It was, when entire, about eight inches long, and it is two inches in diameter from the anterior edges of the dorsal and anal fins. The lithographic delineation gives a sufficiently full exhibition of the characters of this specimen, which appears to be of the same species, or very near the species, last described.

Fig. 2, 2 bis. are delineations of specimens of shale, representing a fish

and its counter print in the rock, just as it was split open. It is a small species of Palæoniscus, compressed vertically, and is contorted as if the fish had struggled to extricate himself when imprisoned in the mud that now forms this rock. The line of dorsal scales, in the middle of this fish, proves its position to be as I have stated, and this opinion is still further confirmed by the shape of the head, and by the open gill covers. This fish must have been caught in the mud alive, since it was in an upright position.

Fig. 3. represents a beautiful and perfect fish, found at the new pit of the Albert coal mine, by Mr. Wallace, Deputy Collector of Hillsboro', who kindly presented it to me. It is compressed vertically, or from the back towards the abdomen, and the head is also vertically compressed between the strata. The large dorsal scales, so characteristic, are seen along the middle of the fish. There is a coprolite seen projecting from near the middle of the fish, and it is not certain whether it is included partially in its body, or was in the mud before the fish was deposited or caught. The body of the fish curves over the coprolite as if it had been a hard substance.

Description.—Fish is 4 1-2 diameters of its body long; body 3 1-2 inches long; head in form of equilateral spherical triangle; gills open; back of head beautifully marked by tuberculations, or striæ and dots; dorsal scales oval-shaped and striated, the most pointed part of the scale being towards the tail,—they run along the entire back to the tail, excepting at the place where the dorsal fin is compressed; scales of body serrated on posterior margins, and striated parallel with their upper and lower edges, and wavy in middle. I am disposed to regard this individual as belonging to the same species as the one before described.

Fig. 2, 2 bis.—Figure 7th represents a lower jaw of a Palæoniscus from the Albert mines. It is interesting as showing the mode of dentition of these ancient fishes; the teeth are here seen to be in a line fixed in regular sockets in the jaw, like those of salmon; the jaw is beautifully marked with little raised dots visible under an ordinary lens; the teeth agree with those observed by Sir Philip M. de Egerton. (See Quarterly Jour. Geol. Soc., Lond., 1849.)

Fig. 8.—This specimen was discovered by me in the shale of the new shaft of the Albert mines. It is peculiarly interesting on account of the entire preservation of its abdominal fin, and also on account of its association with a coprolite which seems to have belonged to this individual.

Description.—Fish, entire; length, 3 7-10 inches; width of the body, 7-10ths of an inch; length of the head, equal to the greatest width of the body; fish, four diameters of its body in length; fins, one dorsal, opposite anal, situated in the posterior, third of body,—anal fin little larger than dorsal; abdominal fin small, situated a little in advance of the middle of the body of fish; pectoral fin a little larger than abdominal; scales, large and brilliant, having a light-brown color striated parallel to anterior margins transversely, and longitudinally in middle, but finer than on anterior margins; tail, more regular than the before-described species, but still unequal; has scales in upper division. This specimen also presents another curious feature; its tail having been amputated by a shift of the strata, and the fracture being polished and re-cemented a little out of place. Head more acute than any of the before-described species, and

very perfectly preserved, having the fine markings of the gill covers and the striæ and markings distinct, and also, what appears to be the impression of the tongue of the fish. The orbitar ring is also preserved, and is a horn-like circle, or ring, filled with bituminous shale or clay. A coprolite under the abdomen of the fish, is a cylindrical mass, rounded at each end, 7-10ths of an inch long, and 3-10ths of an inch in diameter. It is of an ash-gray color, and includes what appears to be small black scales of fishes.

FOSSIL PLANTS OF THE ALBERT COAL MINE.

My attention was so much occupied by the fossil fishes of this interesting mine, that I had omitted to look for the usual coal plants, when I was suddenly called by one of my companions to look at an impression which he had found in splitting a piece of the shale. The instant I saw it I recognized it as a perfect stem of a Lepidodendron, a well-known plant of the coal formation. The rock with the fossil plant was delivered to me, and I have both the stem and the imprint in the rock which contains it. This fossil rendered any further search into the geological age of the fish-bearing rocks of the mine unnecessary; but wishing to obtain more specimens, a number more of slabs were broken open, and large expanded leaves, resembling a species of palm, or a plant quite common in the coal formation of our country, were found, having all the delicate markings, cross veins or bands, and other characters of palm leaves, as has since been shown by Mr. Teschemacher.

Three specimens of this plant were also found in a specimen of the shale, which I obtained on my first visit to the mine. I found a perfect Lepidostrobus, a fruit of the Lepidodendron, according to Brongniart. A number of stems of plants were also found, and some of them, from their forms and delicate curves, appeared to have been succulent hollow stems, or aquatic plants of some kind. These have proved to be species of Sphœrædra. (*Lindley & Hutton*, Vol. iii., Pl. 159.)

Accurate drawings convey a better idea of the form and character of fossils than any verbal description, and therefore I must refer to the accompanying plate, on which are faithfully delineated some of my fossil plants, which were obtained from this coal mine.

Plate III, figures 1 and 2 represent the Lepidodendron found in the shale of the Albert coal mine. Fig. 1 represents the stem of the plant, with its carbonized bark, having all the cortical scales which are so characteristic of the genus. On comparing this plant with the *Lepidodendron gracile*, in *Brongniart's Historie des Vegetaux Fossiles*, Vol. ii., Plate 15, I feel no doubt of its close analogy with that species, which is a well-known plant of the coal formation.

Figures 3 and 3 bis. represent the Lepidostrobus found by me in the shale of the Albert coal mine. Fig. 3 is the fruit in relief, and 3 bis. is the counter-print in the rock split from it. It is difficult to identify the species by comparison with Brongniart's drawings; but no one who compares it with the species of Lepidostrobus, in his plates, (Tome ii., Plates 22, 23 and 24,) will have any doubt of its belonging to that genus. It is probably the fruit of the Lepidodendron gracile, above-mentioned.

Figures 4 and 5 represent Sphœrædra of the Albert mine.

Figure 6 represents our palm-like leaf. It is too wide to be the leaf of a Lepidodendron. Further researches may decide this question. I have Lepidodendra, with their beautiful foliage, from the shales of the coal mines on the Grand Lake, upon the St. John River, very closely resembling the plant figured in *Brongniart's Vegetaux Fossiles*, (Tome ii., Pl. 17, Fig. 1 ;) but none of the leaves have a width of more than half an inch, while these are more than two inches wide. I have before alluded to these palm-like leaves, so characteristic of the coal formation, a fact that no one who is competent to decide will presume to deny, for they are common in all our coal-fields, from Cape Breton to Virginia, both in the bituminous and anthracite coal shales. Instead of objecting to the rocks of the Albert coal mine, as being poor in fossil plants, I would rather express my surprise at finding them at all, considering that the abundance of fossil fishes in those shales indicates that the coal was formed in the bed of a lake, estuary, or sluggish stream Plants will doubtless be found more abundant, as we approach, by mining operations, the shores of this ancient basin, and there may be found more abundantly the fossils of ferns, stems of stigmaria and sigillaria, such as occur in the neighboring coal-fields of Nova Scotia, within fifteen miles of this new coal mine.

The sandstones, I suppose, were the bars and sandy shores of the ancient basin, in which the coal was formed, and if delicate fossils were as well preserved in sand as in clay, we should doubtless find them richer in their flora than the more richly endowed and conservative clayey shales.

I come now to the conclusion of the whole matter, by deciding that *the Albert coal mine is in the true coal formation*, and the rocks being accompanied with the most indisputable evidence of the coal fishes and the coal plants, which alone would settle this question, if we had not abundant stratigraphical proofs of the same fact, which are everywhere extant around the mine, and in the immediate vicinity. I also declare that the fossil fuel obtained from this mine is *a highly bituminous coal*, suitable for the production of gas for illumination, and for flaming fires, and that it *is not asphaltum*, and will not serve as any substitute for it in the Arts, it being incapable of fusion by heat, and not applicable to any of the purposes for which asphaltum is usually sold in the commercial markets of the world.

The following contrasts of the characters of asphaltum and of the Albert coal, set in a clear light the characteristic differences between them. Every one of the experiments has been faithfully performed by me.

Asphaltum from the Dead Sea—from Cuba, (Chapapote,) and from Trinidad.	*Coal from the Albert Mines, of Hillsboro', N. B., obtained by myself at the mine, May and June, 1851.*
Reduced to fine powder, and spread on a sheet of metal, and heated to 400° F., melts and runs into a perfectly fluid mass, boiling rapidly as the temperature rises, and giving off a vast quantity of volatile matter and smoke.	Reduced to fine powder, and spread on a sheet of metal, and heated to 400° F., no change whatever takes place. It does not melt, run or smoke at all, and does not soften.

At a temperature of 600° F., it is decomposed with great ebullition and rapid disengagement of smoke.	At 600° it does not decompose at all, nor does it melt at any temperature, but decomposes at a red heat, without fusion, or running together at all.
In mass, at a temperature of 300° F., it melts and runs; at 700° the asphaltum is entirely decomposed.	At 300° no change; at 700° it begins to soften a little, and becomes like Newcastle coal, soft, or cements, and then at a red heat decomposes and forms coke.
In boiling water asphaltum softens and becomes plastic, and adheres to the bottom of the vessel. It gives off naphtha.	In boiling water the Albert coal undergoes no change, and remains as brittle as ever. It does not give off any naphtha.
Dropped on to melted tin, which has a temperature of 442° F., it is immediately melted and decomposed, with copious fumes.	Dropped upon melted tin, it does not melt or undergo any change whatsoever, and when held beneath the molten metal it does not melt, nor give off any volatile matter, nor even soften.
When dropped upon molten lead, which has a temperature of 612° F., it instantly melts and decomposes, with a great sputtering, floating on the surface of the lead, and boiling rapidly, giving out thick and dense smoke and fumes.	Albert coal, dropped into molten lead, does not melt, and even when plunged beneath the surface of the molten metal, and held there by forceps, it does not decompose nor yield any gaseous or volatile matters, or smoke in the least.
Dropped into melted zinc, which has a temperature of 700° F., it decomposes instantly, giving off a dense smoke.	Dropped into melted zinc, Albert coal does not melt nor decompose. Held under the molten metal, by means of forceps, it becomes elastic, and softens like Newcastle coal, but does not give out any gas or smoke.
Asphaltum is readily melted in a ladle, and can be poured out like tar or molten pitch.	Albert coal cannot be melted in a ladle, and poured out. In a confined place, as in a crucible, with steep sides, or in a thimble, the Albert coal swells and cements, but does not melt and run.
Melts, and runs, and drops, in a liquid state, when placed in the flame of a candle or lamp, so that it requires some management to set a lump of it on fire, so as to keep it burning when removed from the flame, the heat of the lamp causing it to drop.	In the flame of a candle or lamp, the Albert coal takes fire, but does not melt and drop, and can be burnt to coke on the under side, without any dropping from heat of the flame after removal from the lamp.

Dissolves readily in naphtha.	Does not dissolve in naphtha, but only yields, at the most, 5 83-100 per cent. of its bitumen, when heated in that fluid for some days.
Dissolves instantly and entirely in benzole and in oil of turpentine and in chloroform.	Yields, at the most, from fourteen to twenty per cent. of its bitumen to all these solvents, and the 86 or 80 per cent. of matter remaining is entirely insoluble in all liquid hydrocarbons.
Yields resin to alcohol and ether.	Does not yield resin to alcohol or ether.
Is commercially employed, on account of its ready fusibility and solubility, and is used for cement and for varnishes.	Is commonly used for coal, and in gas works is employed in the production of bi-carbureted hydrogen gas for illumination. Is not fusible, hence cannot be used like asphaltum for cement, and yields so little soluble matter as to be of no commercial value in the making of varnishes, and cannot be sold in the market as asphaltum, without fraud.
Melts, and runs immediately through the grate bars, so that it cannot be employed as fuel, and cannot be burnt as a coal.	Does not melt or run through the grate bars, but burns freely, like highly bituminous or fat coal, forming a spongy coke, that cakes readily, and after the bitumen is burnt up the coke burns, like that of Newcastle coal.

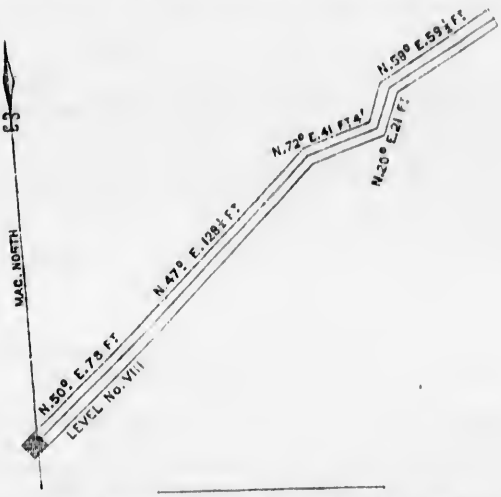
Respectfully, your obedient servant,

CHARLES T. JACKSON, M. D.,
Assayer to the State of Massachusetts, &c. &c.

STATE ASSAYER'S OFFICE,
Boston, Sept. 27th, 1851.

NOTE.—W. C. Redfield Esq., of New-York, on examining my fossil fishes from the Albert coal mine, declares his conviction that they are fishes of the coal formation. Mr. Redfield is well known as a gentleman well acquainted with the fossil fishes of America.

Plan of Level No. 8, Surveyed by C. T. Jackson, June 6th, 1851.



COPY OF DR. ABRAHAM GESNER'S LETTER TO DR. JACKSON,

REFERRED TO ON FOURTH PAGE.

Halifax, 25th March, 1851.

DEAR SIR:—I had taken the liberty to republish your analysis of the New Brunswick asphaltum, with that of Dr. Chilton, and others, because it agreed so nearly with the views of English and Scotch chemists and geologists, who had visited the deposit. Dr. Chilton has subscribed since to a certificate directly contrary to his first one, and I have deemed it but due to you, as well as to Professor Robb and others, to make my acknowledgements to your superior discernment and ability. Being the proprietor of the asphaltum mines, I have not that interest in the question some have supposed, whether the material is either one or the other, namely coal or asphaltum; my title does not altogether rest upon this query.*

I send you the papers I have written upon the subject, merely for the purpose of introducing the local facts that might not reach you through any other source, and I may find it necessary hereafter to solicit your services to explore the district, to establish the character of the rocks in which the asphaltum is found. As soon as the vessels begin their trips, I will send you some of the naphtha and petroleum, associated with the compact material, and I can only add that it will afford me much pleasure to aid your inquiries in this quarter, and to promote your interests in these provinces. I write under heavy domestic affliction, which it has pleased God to lay upon me, and trust that you will make every allowance for this mode of introduction.

I am, dear sir, very truly, respectfully yours,

ABRAHAM GESNER.

CHARLES T. JACKSON, M. D.,
Professor of Chemistry, &c. &c.

P. S. Since writing the above, I have found a small piece of petroleum from the place, and beg to send it herewith. A. G.

* NOTE BY PUBLISHERS.—In reference to this assumption, it is only necessary to state that Dr. Gesner holds a lease of four acres of land, "*except and reserved, nevertheless, to the Crown, all coals, and also all gold and silver, and other mines and minerals.*" Whereas, E. Allison, Cairns, and others, hold a license from the Crown, "to work any mines of gold, silver, copper, platina, lead, coal, or other mineral of any and every description," and also the land itself in fee, adjoining the above four acres, beneath which the deposit is supposed to exist. [See the Hon. the Master of Rolls' decision, adverse to Dr. Gesner, 2d April, 1851.]

RICHARD C. TAYLOR, ESQ., OF PHILADELPHIA,

Geological and Mining Engineer, and Author of "Statistics of Coal,"

testified at Dorchester, N. B., as follows:—

"To melt is one of the distinguishing features of asphalt." "*As a Geologist, I would not pronounce a substance which would refuse to melt upon iron, heated to* 600° *F., to be asphaltum.*"

"I found no soft liquid or brown-colored substance, *or springs of naphtha or petroleum*, at the Albert mine or near it. *I looked for them* in the mine and its vicinity, but found none. *I did expect to find them in the Albert mine.*"

REPORT OF DR. JOHN BACON, JR'S., MICROSCOPIC EXAMINATION OF THE HILLSBORO' COAL.

BOSTON, Nov. 3d, 1851.

EDWARD ALLISON, ESQ.:

Dear Sir:—As the result of my Microscopic Examination of the Hillsboro' Coal, I am able to report the existence of vegetable structure in the interior of the masses. The specimens examined were taken by myself from a barrel of coal in the laboratory of Dr. Chs. T. Jackson, stated by him to be from the Albert Mine, in Hillsboro', N. B.

Sections of the coal were ground sufficiently thin to allow light to pass through them, and carefully polished. Some of these exhibit, under the microscope, contorted fibrous tissue, enclosing cells, and penetrated by numerous apertures, approaching a circular form, which appear to be transverse sections of vessels. Others show elongated cells or vessels, ranged side by side. These tissues occur in patches not sufficiently extensive or continuous to enable me to form a positive opinion in regard to the nature of the plants to which they belong.

It is always a matter of difficulty to detect microscopic structure in bituminous coal, as the vegetable tissues are usually obliterated, more or less completely; but the evidence of structure in the Hillsboro' specimens are abundantly sufficient to prove that the substance is coal, and not ashphaltum.

Respectfully yours,

JOHN BACON, JR.

REPORT ON GEOLOGICAL RELATIONS

OF COAL MINE IN HILLSBORO',

BY DR. J. G. PERCIVAL, GEOLOGIST,

OF NEW HAVEN, CONN.

In the following statement, I confine myself to the Geological relations of the subject in question, and to a few of its more obvious characters, without touching on its specific chemical properties, or on the specific characters of the fossils in the accompanying rocks; such specific chemical properties and fossil characters have been referred to Dr. C. T. Jackson.

After an examination of the mine, and the immediately accompanying rocks, as well as the rocks in the vicinity; and after testing the substance by the action of heat and combustion, in connexion with different specimens of asphaltum,—I have come to the conclusion that this substance in question *is a coal, and not an asphaltum.* The immediately accompanying rock is a brown bituminous and calcareous shale, partly thin, and partly thick and more calcareous, with interposed bands and nodules or balls of limestone and ironstone, with iron pyrites in seams or disseminated, with fossil fishes and fish-scales and teeth, in some parts abundant, in others less so, and with occasional distinct remains of plants, and a few distinct points of charcoal lignite. The surface of the layers is generally smooth and glossy, particularly in the walls of the mine, and occasional layers occur, composed of very thin shelly fragments, still more smooth and glossy, and readily decomposing into a soft clay. Such a shale, composed of very small fragments, I have sometimes found forming a thin stratum between the coal and the adjacent thicker shale. The shale in the vicinity of the coal-bed is, on the whole, thicker and more calcareous and bituminous, than at points more remote in a lateral direction, but at an excavation in the direction of the bed towards the north-east, made by Mr. Foulis, the shales are nearly or quite as bituminous as at the mine, and abound in similar fossils. In tracing the bed of the streams near the mine, I found, as I receded from the mine, interposed thin beds of blue limestone and gray fine-grained sandstone or grit.

In examining the country east and south-east of the mine, towards the Peticodiac River, I observed first a dark-brown conglomerate, apparently deriving its color from the matter of the shale, which I judge, from its position and dip, as compared with the eastern border of the shale, as far as observed, to overlie the shale. The shale, which I last observed in place in that direction, had a moderate dip (about 15°) easterly. The

conglomerate, where observed nearest the shale, and at no great distance, is on higher ground than the shale, and with the same dip. Hence I conclude it probable, although the junction of the two rocks has not been there observed, that the conglomerate overlies the shale. (Since writing the above I have been able to observe the junction of the shale and conglomerate, in a ravine on the south side of the ridge, north of Frederick Brook, three-fourths of a mile west of the mine. The shale there dips under the conglomerate; the two rocks being separated by a narrow bed of fine-grained sandstone, with which the shale is there also interstratified. The same irregularities in direction and dip occur there in the shale, as in other localities noticed, and it finally dips with its sandstone under the conglomerate, at a moderate angle north-west. At one point in the ravine the shale includes very thin seams of coal, similar to a coal in a similar shale, in similar very thin seams, at a locality two or three miles south-west of the mine (Martin's). At that locality, the coal is regularly interstratified in even layers in the shale; at the ravine it occurs in seams interposed in a fragmentary shale.)

Further easterly, towards the Peticodiac, the conglomerate is succeeded by an overlying friable and decomposible argillaceous red sandstone, with interstratified beds of gray sandstone or grit. This band of red sandstone appears to me, from its position and direction, to include the deposits of gypsum at the Whitehead and vicinity, and at the Demoiselle River, near Wilson's. The red sandstone and gypsum, at the first-mentioned locality, are underlaid by a bed of blue limestone, resting on a brown conglomerate, resembling that approaching the shale of the mine. This limestone and conglomerate may be traced to the hill west of the Peticodiac, just north of Mr. W. Cairns' residence; the gypsum being found in the hill next west.

In proceeding easterly from the mine, the red sandstone is overlaid by a coarse light-brown conglomerate, with interposed beds of gray sandstone, which forms the summits of the hills to the banks of the Peticodiac, the red sandstone appearing in the valleys. On the bank of the river, at the two points south of the coal wharf, the overlying rocks appear in an order corresponding to that just stated; but by an apparent deflexion in their course, the dip is southerly (about S. S. E.;) a darker brown conglomerate appearing at the base in the north point, overlaid by the friable red sandstone with an included bed of gray sandstone, and this by the light-brown conglomerate with its beds of gray sandstone, while in the south point, there occur, from the southerly dip, only the upper part of the red sandstone, and the light-brown conglomerate, as above. In the upper light-brown conglomerate and its gray sandstone, at least at the south point, are found large and distinct fossil plants of the coal formation (jointed calamites, and other reed-like plants, such as everywhere occur in the true coal formation of this country,) accompanied with other smaller more flag-like fossils, also found in the same geological localities. These smaller plants are found in great abundance in the bed of gray sandstone included, at the north point, in the underlying red sandstone, particularly in certain thinner more slaty layers of that rock, and at the south point, in similar layers of gray sandstone, included in the upper conglomerate; thus indicating that the whole series of beds, at those points, belongs to the coal formation. In the shales of the mine, both in its immediate vicinity, as well as more remote from it, flag-like plants are found, quite similar to those accompanying the gray sandstone last mentioned, from which it may

be inferred that those shales are of the coal formation. I do not refer to the fishes of those shales as also leading to the same conclusion. I will only state, that Dr. Jackson, sustained by Prof. H. D. Rogers, has determined them to be fishes of the coal formation. I thus feel myself warranted in concluding that the mine is situated within the coal formation.

I will now proceed to consider the mine itself, in order to determine whether it has the appearance of a bed of deposit, or of an injected mass. The direction of the principal and least disturbed part of the bed is N. E., with little variation; the prevailing dip is N. W., at a very large angle (75°–80°:) the N. W. side may thus be considered as forming the roof; the S. E. side, the floor of the bed. On entering the mine at Duffy's level, the first impression is that it is a highly inclined bed, with parallel walls; the two sides, where first observed together, being nearly conformable, with the prevailing N. W. dip. As we proceed, irregularities occur, particularly on the S. E. side; the N. W. side apparently preserving its N. W. dip with greater regularity: still the general appearance of a bed continues; the S. E. wall, though often showing a S. E. dip, still returning again to the N. W., and though occasionally changing its direction, yet resuming continually its proper course north-easterly. On proceeding into the lower levels, and traversing the more regular portion of the bed, which forms much the largest part of it, the same impression remained in my mind, of a bed highly elevated, and consequently much disturbed. In descending, the bed widens very considerably in its middle portion, but again contracts towards the lowest level; the sides at first diverging, most so on the S. E. side, and again approaching by a change in the dip on both sides, the S. E. side dipping from S. E. to N. W., and the N. W. side from N. W. to S. E.; the greater change, however, occurring on the S. E. side, as usual. This enlargement of the bed appears thus to have been the effect, not of a rupture, and anticlinal displacement, by a force from beneath, but of a bulging of the bed in that part of it, more particularly on the S. E. side. The bed, after this enlargement, contracts, not only in its descent, but also in the direction of its length; the walls, as we proceed N. E., becoming, in the narrower part of the bed, much more regular, and nearly or quite conformable, in a position nearly vertical. The bed then narrows quite abruptly, extending as a vein one to two feet wide, in its usual N. E. direction between the strata, but has not there been excavated. At this point occurs a remarkable shift or fault, crossing the strata obliquely N. N. W., by which the coal passes, first in a very narrow seam, which then expands gradually, and resumes nearly its former N. E. direction between the strata, again bulging out, and arching over towards the S. E. In this direction it continues some distance, and again narrows abruptly in a *cul de sac*, formed by an overarching of the strata, and then extends, on its S. E. side, in a narrow vein, between the strata, which has been excavated to some distance, without showing any enlargement. From obstructions in the S. W. part of the mine, I have not been able to examine it in that direction. In the main body of the mine, where it extends north-easterly, between the strata, there appear, at intervals, along the walls, in some parts more frequently, in others less so, protruding ends of apparently fractured strata, called onsets by the miners, against which the coal is immediately applied. It has appeared to me a remarkable circumstance, that with very few exceptions, and those but slightly marked, the ends of these strata point on both sides of the bed in the same direction towards the south;

on the S. E. side, S. W.; on the N. W. side, S. E.; and that they occur more frequently on the S. E. side. If the walls had been ruptured and separated, we might expect one wall to correspond to the other; the N. W. wall exhibiting ends pointing N. E., toward the ends on the S. E. wall pointing S. W.; or if they did not correspond so directly opposite each other, yet at a distance measured by the extent of the shift or fault; but in tracing the walls to a much greater distance, I could not perceive any such correspondence. In some instances I observed the strata forming the wall of the bed, on the S. W. of these onsets, terminating with their ends butting against the sides of the out-turned strata; the latter, as it were, dipping into the walls obliquely in an E. S. E. to E. N. E. direction, and the ends of the former, as it were, pressed against their sides, so as to be turned in towards the bed, while the out-turned strata again, by a sudden flexure, were turned in the direction of the walls; the whole presenting the appearance of a stratum broken across, and bent out abruptly on the N. E. side, and the S. W. portion pressed against it, as if by a force acting from that direction. In other instances the strata appear to have been merely bent, without fracture, or with only a simple fissure at the flexure; forming protuberances on the walls, as if the latter had been wrinkled by a protruding force. Other oncasts appear to be nodules projecting from the walls, either of limestone or ironstone, such as frequently occur in the shales on the surface, or in the other excavations (the new shaft and the water level), and in one instance which I examined, of the bituminous shale, quite filled with small irregularly intersecting veins of calcareous spar. These nodules lie across and interrupt the strata of the shale, wherever they occur, as well as the coal, when they project from the walls of the bed. I cannot say that more of these nodules or concretions (particularly of ironstone) occur on the S. E. lower side than on the other, though I have observed more on that side, and such is also the remark of Mr. Brown, the manager; which, if true, would correspond with the more usual position of the ironstone in coal-beds. Balls or nodules of ironstone are remarkable features of coal-fields, and such occur not unfrequently in the shales of this mine. Another circumstance in the mine has appeared to me worthy of notice, namely, the soft smooth glazing which is spread over the walls, even over the apparently fractured ends of the strata, and in many instances, a thin layer of a very thin and small fragmentary clayey shale, highly glazed and usually, though preserving its form, softened into a fine clay, interposed between the coal and the thicker shale; all this apparently indicating that the bed assumed its present form in a soft aqueous condition, and not in consequence of a rupture of rocks already consolidated with injection of a substance fused by heat. The very numerous, often even minute flexures and contortions, and larger overarchings, in the bounding shales, also appear to me to indicate such a soft unconsolidated condition. As I have before observed, the greatest appearance of direct fracture and injection occurs at the shift or fault. In examining the shales in the neighboring streams, similar irregularities are observed in them, which would seem equally to require rupture and injection. Nodular bands of limestone and ironstone are seen running between the strata, then crossing them, and then resuming their former course. Similar appearances occur in the shales alone. In one instance, a band of thick hard even shale crossed the bed of Frederick Brook, directly intersecting, nearly at right angles, a bed of very thin wavy shale. The remarkable

overarchings at the N. E. end of the mine, find their parallel in the shales remote from the coal-bed. In the water level, driven on the N. W. side of the bed, nearly a hundred feet towards it, there commences, near its entrance, such an overarching, forming a regular vault nearly the whole length of the level, which bears about East, the strata at its present extremity turning towards the N. E. and rising into a dip corresponding to the prevailing dip of the mine; thus corresponding to the arch over the *cul de sac* at the N. E. end of the mine, and to its rising into the regular course of the bed, along the small interstratified vein, in which it is there continued. These instances show that the peculiar irregularities of the coal-bed are not confined to it, but extend widely through the accompanying shales. I have already observed that the shale on its E. side apparently dips east by a moderate dip, under an overlying conglomerate. In a section of the shale in the side of the road leading to the mine, it has at first that dip, then very gradually arches over to the west, at first moderately,* then with an increased dip. It then appears very irregularly contorted, as if wrinkled in short and steep waves, and at last disappears beneath the soil in a direction bearing south-westerly, with a large dip S. E., and that at a short distance from the mine. On the other side of the mine, the obstruction offered by a thick forest, has prevented me from tracing the shale to any considerable distance. In following up Frederick Brook, the strata pursuing the general S. W. direction of the coal-bed, first dip with it N. W. at the same high angle, then become nearly or quite vertical, and then change to a S. E. dip; then after some interval, are highly contorted, and again resume their former N. W. dip.

After collecting and considering these details, the conclusion at which I have arrive -, that, in the larger and more regular part of the mine, the appearances are those of a bed of deposit, not of an injected mass; that this deposit assumed its present form in a soft aqueous condition of the including rock; and that the irregularities, comparatively small in that part, and more remarkable and difficult to explain in the shift or fault, and in the N. E. part of the mine beyond, are the result of the disturbances which must necessarily have accompanied the change from a nearly horizontal to a nearly vertical dip of the strata, accompanied apparently by some lateral movement in their direction from W. to E. That such a movement may have occurred, may be inferred from the apparent change from an E. to a S. E. or more southerly dip in the strata in receding from the conglomerate next to the shale to the Peticodiac. I offer this only as a hint, to be followed out more exactly, only by a careful detailed examination of the mine and the surrounding country. It is well known that great disturbances and irregularities occur in many coal fields, which do not however deprive such disturbed beds of their place among coals. Examples of this kind may be found on R. C. Taylor's Statistics of Coal, (see pages 171, 277, 279, &c.)

I will now offer some remarks on the coal itself. This, like cannel-coal and jet, is a highly bituminous substance, free from the laminated or stratiform structure of common coal, or in which it can be only obscurely perceived, and in which no, or very indistinct, traces of organic texture

* At this point the shale overlies, in a thin bed, a thicker bed of very soft clay, obviously formed from the decomposition of shale, the structure of the shale being distinctly observable in at least part of it.

can be distinguished. Such coals have been considered as originally in a state of complete liquefaction, or nearly so, at least in a soft pulpy state. Such a coal, in hardening, would be, of course, governed by those laws which influence the cooling or hardening of fused or liquid matters. Such substances, in hardening, have a tendency to divide by jointed seams or planes of cleavage, which are controlled in their direction by the bounding or including walls, one set being perpendicular to them, in two directions, forming the sides of the resulting solid ; another parallel to them, forming its ends. The most striking or principal seams—those which give the columnar structure—are perpendicular to the walls, or passing from wall to wall. These are seen remarkably distinct in vertical, or nearly vertical, trap-dikes, and less so in those which are inclined. The seams in this coal-bed, as far as I have observed, strictly conform to this law. The seams in the middle of a large mass, are less frequent than on its sides, adjoining the walls ; and the seams in small masses, or narrow beds or veins, are more frequent throughout, as on the sides of the larger, or in other words, the same matter on the sides of larger beds or veins, and throughout smaller, breaks into smaller jointed fragments. This is found, also, to prevail in trap-dikes, uniformly, as far as I have observed, and is equally observable in the coal of this mine. The direction of the seams corresponds to the direction of the walls, shifting with and conforming to their irregularities. This, so far as I have seen, is strictly observed in the mine ; the middle part of the wider portion of the bed, where the walls have a near approach to parallelism, appearing to be divided by nearly horizontal and vertical planes, passing from wall to wall, and crossed by other vertical seams parallel to the walls. These divisional planes are very striking in that portion of the bed, and might lead a hasty observer to suppose that such was the general law of division. But a more minute examination will show that where the walls are inclined the seams are equally so, and that, in truth, these divisional planes strictly conform to the surface on which the coal rests, and follow all its irregularities. All these planes are due to the hardening of the substance merely, and have no relation to its original laminated structure. But, besides these, I have observed, in a strong light, delicate lines traversing the substance in the more regular part of the mine, parallel to the general direction of the bed, which may indicate its original lamination. More exact observations might be made by a microscope, both in relation to these and to organic structure, but I leave such to Mr. Teschemacher, who has undertaken that investigation. The division by jointed seams, above mentioned, is not peculiar to substances originally fused or liquid, but is found in substances which have hardened from a merely soft state, as clay, and also in common bituminous coal.

I have stated in the beginning of these remarks, that I do not undertake to investigate the specific chemical properties of the substance in question; but there are certain easy and obvious tests, by the action of heat and combustion, by which it is generally allowed that coal and asphaltum may be distinguished : these I have applied, and from the result I have concluded that so far this substance has the properties of coal, and not those of asphaltum. If this substance be placed in the flame of a candle it does not melt at all, but simply cracks and flakes apart, while asphaltum (that of Egypt, Cuba and Trinidad) melts readily, and falls in drops. Placed on a red hot iron, the different varieties of the mine

(that breaking in large fragments, and that divided into thin layers and small fragments or the structural variety) burn with a full flame, but less so and less rapidly than the asphaltums, and at the same time swell and jet out like the more bituminous coals, and leave behind a bulky coke or cinder, while the asphaltums melt and run as they are burning, and leave only a flat button, composed chiefly of earthy impurities. Placed on a hot iron, just below ignition, the asphaltums melt and run like wax, while this substance only separates in flakes, and slightly softens, like the more bituminous coals. I need not say that all these results connect this substance with the coals, and not with the asphaltums.

The more important conclusions, which I have stated in the preceding remarks, may be here collected in distinct propositions:—

1st. The bed in question is situated in a bituminous shale, which, from its own fossils, and from its connection with rocks, having the fossils and other characteristics of the coal formation, belongs itself to that formation.

2d. The shale, for a considerable distance around the mine, exhibits great irregularities and contortions, caused by disturbances which have changed its dip from horizontal to nearly vertical.

3d. The principal portion of the mine lies, on the whole, in a direction between the strata, and presents on the surfaces of its walls, appearances of deposition in a soft aqueous condition, and not of a rupture and injection when the rock was indurated.

4th. The irregularities in the mine, even those at the fault, and in the north-east extremity, correspond with irregularities observed in remote parts of the shale, and may be explained by the disturbance necessarily arising from the change from a horizontal to a nearly vertical position of the strata, and perhaps from a contortion in their general direction.

5th. The substance is analagous to cannel-coal and jet, in which the original lamination is nearly or quite obliterated, and which, like all substances which have hardened from a liquid or very soft state, are divided by jointed seams, conforming, in their arrangement, to the bounding walls; and, conformably to this, the jointed seams or divisional planes of the bed, instead of being always horizontal, and uncomformable to the walls, are, in every point examined by me, strictly conformable to them.

6th. This substance, when tested by the flame of a candle, and by red-hot iron, or iron heated just below ignition, exhibits the characters of coal, and not those of asphaltum.

That a highly bituminous coal, in which the original vegetable structure is apparently obliterated, may be formed by mere aqueous agency, is proved by the fact, that such a coal, burning very freely with flame, is found at the bottom of peat bogs. I have found such, in different instances, in peat bogs in Connecticut, resting on the earthy bottom. The same fact is stated in relation to peat bogs in Ireland, and such a coal is described as found in peat, by Dr. C. T. Jackson, in his report on the Geology of Maine.

JAMES G. PERCIVAL.

St. John, Aug. 29th, 1851.

NOTE.—I have observed, in a series of fossil trees recently uncovered in a bed in Ross' Freestone Quarry, in the coal formation of Pictou, N. S., a bituminous substance, having the same external characters as the coal of the Albert mine.

REPORT ON ALBERT COAL,

BY DR. AUGUSTUS A. HAYES,

STATE ASSAYER OF MASSACHUSETTS.

Messrs. Cook & Smith, New-York:—

Dear Sirs:—Having at an earlier date expressed the opinion that the variety of coal found in the Albert Company's Mine, in Hillsboro', New Brunswick, is a bituminous coal, I now present you, somewhat in detail, the reasons for such an opinion. With high respect, A. A. Hayes.

1 *Pine-street, Boston,*
15th Sept., 1851.

As introductory to the facts known to me as early as the 15th April, 1850, I may state that, through the kindness of my friend, Dr. C. T. Jackson, I have been permitted to examine his field-book, containing his notes, sections of strata, and admeasnrements, with the series of organic remains in quantity, which he had collected from the rocks, including the coal.

The advantage thus derived from his observations, enables me to express my conviction that the facts accord entirely with what is known of the geology of coal formations generally.

The more recent investigations of the fossils of the coal eras, have given to this part of geological science a definiteness unknown in other departments, where less numerous observations have been made.

Reliance may be fully placed on the facts which have thus been established, as bearing on the age of this deposit, in the series of rocks inclosing it.

The fossil vegetation is that of the coal measures, while the organic remains of the species of fishes, constituting the larger part, refer the deposit to the carbonaceous period with distinctness. Indeed, the age of this bed seems to be as clearly recorded by the fossils in the rocks, as if it were printed in chronological tables; and this record places this form of carbonaceous matter in the period during which *bituminous* coals were formed in various parts of the world.

The bed presents, at first view of the section, a peculiarity which arrests attention, and which has suggested a doubt of its form corresponding to known beds of coal, elsewhere observed. It differs in the higher angle of its roof and floor from the coal-beds of England, where great simplicity prevails. Dr. Jackson's sections, read in connection with his notes of measured dip and direction, not only give to this mine the essentials of a true bed, but show it to correspond with other beds of coal, in relation to which no doubt can exist, or ever has existed.

Thus, in the section of the mine of Montchanin, are presented, on a grand scale, the same features as are deemed peculiar in the Albert

Company's mine. This section will, I hope, be given with that by Dr. Jackson, and to it I refer, concluding from the evidence now before us that, geologically speaking, the Albert Company's mine is a bed of highly bituminous coal, in which the workings are progressing.

Leaving this part of the evidence of its common origin with varieties of bituminous coal, we come to consider it simply as a mineral body, of the combustible class, and to find its true place in known arrangements of species.

Its physical characters of fracture and specific gravity are subject to the same variations which we recognize in other kinds of coal, and both have a connection with the material from which it originated. In many specimens, the conchoidal fracture is as perfect as in the anthracites. In other cases, a mixed fracture causes it to approach the cannel coal on one side, and the laminated variety of bituminous coal on the other.

The important researches of J. E. Teschemacher, Esq., have taught us to study the structural form of coals, in connection with the organic forms composing, in part, its mass. Frequently, we find in the Albert Company's coal the same markings made by the plants of the coal era, as are found in the cannel coal, and harder anthracites; and variations in fracture can be observed, which were produced by these remains. This coal, like some anthracites and lignites, is black, without the slightest degree of translucency; a character separating it from the bitumens, which transmit a red brown light. Its powder is black, as is also its streak, while all the bitumens give a brown powder, and exhibit the same color in their streak, At all temperatures below 450° F. this coal is brittle, and its powder does not agglutinate, while the bitumens are unknown at this temperature, excepting in the state of vapor, and their powders agglutinate at 100° F.

Specifically, this is one of the lightest coals known, being nearly of the same density as bitumen free from earths. The bituminous part of coals, or the inflammable portion strictly, is variously composed, both in relation to ultimate elements, and the modes in which these primary bodies unite to form secondary compounds; hence specific gravity, in reference to chemical composition, is a character of little importance. This character is, however, influenced by the mechanical arrangement of the constituent bodies; and in this coal the disposition shown to decompose into water, naphtha, and carbon, has a connection with the low specific gravity. Trials made on specimens from various parts of the mine, show a density, compared with pure water at 60°, of 1.0836 to 1.1113.

There are two combustible bodies which, physically considered, bear some resemblance to the Albert Company's coal, and it is important that the characters of these substances should be compared with those of the coal. One is the chapapote, or bitumen, from near Havana, Island of Cuba; the other is the asphaltum, as imported for chemical purposes. Having been employed as early as 1839 to examine the chapapote, I have learned many of its characters. It is a brilliant black bitumen, remarkable for its purity; its powder is a shade of brown; fracture conchoidal; specific gravity, pure pieces, 1.1650 to 1.1700, and remarkably uniform. It has an asphaltic odor, and easily breaks, with a slight yielding. Thin portions transmit red-brown light. It appears to be an oxydized maltha or petroleum, which, once fluid, has become solid at ordinary temperature, by oxydation, precisely what we observe daily taking place at the Pitch Lake of Trinidad. Once solid, oxydation proceeds more slowly, and the

bitumen retains, at a low temperature, its characters, with some permanency. It presents no traces of organic markings, having the uniformity, fracture, lustre, and general characters of a resin.

Asphaltum, as is well known, is a fluid body, which has become solid by the action of atmospheric air. It exudes from the strata, and flowing to the lowest point, generally appears on the surface of water. The variety giving the name to the species comes from the Lake Asphaltes, and is always more pure when taken from near the surface of water over which it has flowed, than when taken from the earthy strata. The fracture of this substance, at low temperature, is conchoidal; its color black-brown; color of its powder brown; its specific gravity, which is much affected by the proportion of sand, is 1.16.

The physical character of color in mass, is the same in chapapote and Albert Company's coal, but the latter is opaque. Chapapote, asphaltum, and Albert Company's coal, agree in specific gravity, nearly, while they differ in fracture and lustre.

When we view the three substances, Albert Company's coal, chapapote, and asphaltum, in relation to their uses in the arts of life, their physical characters become of secondary importance. For instance, if chapapote is to be dissolved in oil of turpentine, to form a coarse varnish, its fracture and specific gravity are points of no importance; nor is it a matter of any consequence, in the case of asphaltum, whether its color is gray, brown, or black, if it forms with oil a shining mass.

The value of these substances depends on those characters which are called chemical, and their claims to places in any proper arrangement are founded on these. If, therefore, the Albert Company's coal has the chemical characters of asphaltum, or of chapapote, then for all useful purposes it must be ranked with these, take its place in the family of the bitumens, and lose its claim to the name of coal.

The pervading influence of heat is of the first importance in connection with these bodies, for their uses in the arts are directly connected with this, and the action of solvents is modified by this power.

Albert Company's coal, either in powder, or in masses, exposed to the temperature of 220° F., suffers no change. Chapapote, at 214° F., melts from a previously softened state to a uniform fluid, which may be poured from one vessel to another, or passed through small orifices. Asphaltum, in its varieties, suffers the same change of form, and, exclusive of earthy matters, has the same characters below 220° F. Albert Company's coal, placed on a bath of melted tin, suffers no change, and when plunged below the surface it remains unaltered, at 500° F. Chapapote, becoming fluid, cannot be placed on melted tin, without being rapidly changed, and escaping as vapor and smoke. Placed in tubes, and immersed in melted tin, it melts quickly, gently boils, and gives off more than half its weight of fluid matter, a mixture of petroleum and volatile hydrocarbons. Asphaltum undergoes similar changes when placed in tubes, and immersed in melted tin at 500° F. Marked as are these differences, the character of melting to a fluid, and then permitting volatile fluids to pass from them without any swelling greater than that produced by ebullition, is very important. It assimilates the bitumens to ordinary turpentine and tar, which thus divide into volatile spirits, and solid residues, having a porous form. These two substances, chapapote and asphaltum, melting at about the boiling point of water, cannot be used as fuel ordi-

narily; and dividing by heat into fluids and solids, they cannot be used alone for producing gas economically. When Albert Company's coal is placed on melted lead, it does not melt; but when plunged below the surface, and retained there, it softens, so far that it can be impressed. The temperature in this case is near 650° F., and after long exposure, the fragments do not lose their forms. Either chapapote, or asphaltum, is entirely decomposed at this temperature, exhibiting the characters of true bitumens.

Albert Company's coal, exposed to a gradually increasing temperature from 650° F., begins to swell at 700°, and at about 750° decomposition commences. At this point the coal rises in puffs, the elements of water combine to form vapor; naphtha gases and volatile alkaloids are also produced. *The coal does not melt*, either by slow or rapid application of heat. It tumefies, and takes the form of the containing vessel, while the vapors are escaping, resembling, in this, the action of heat on wool, hair, &c. As no substance can be called bitumen which does not melt below 220° F., the Albert Company's coal is far removed from the class of bitumens.

The influence of heat enables us to apply a distinctive test, which in its results may be considered as decisive. If any variety of bitumen is supported on a wire mesh, having four or five holes in the linear inch, and heat be then applied from a flame below, the bitumens will melt and flow away. When coal is subjected to the same trial, it inflames or ignites, and is consumed. Albert Company's coal, exposed in this way, inflames, swells and consumes, except ashes. When an anthracite coal fire was burning under a steam boiler, Albert Company's coal was suddenly thrown over the hot fuel; the coal caked and burnt away, without any fused portion dropping through the intensely heated fuel. To render this experiment more satisfactory, the whole of the coal was removed, leaving the walls and bars red hot. Albert Company's coal being then supplied, the combustion was active, and by frequent stirring, was continued some hours, steam being generated, and less ash than usual fell through the grate. It is thus proved that the Albert Company's coal has one of the essentials of coal, the property of burning from a grate being characteristic of coal, in connection with its form. The relations of Albert Company's coal to heat, establish its affinities to coal positively, while the bitumens become clearly distinguished; it is deemed important, however, to examine its relations to solvents, selecting those which, used in the arts, serve to modify the form of solids, and adapt them to certain purposes. In the comparisons which follow, the circumstances were made as nearly alike as was possible.

Action of Oil of Turpentine, *(Spirits Turpentine.)*—Chapapote, dissolves in this fluid heated to 212° F., leaving only some earthy matters. This is a perfect solution, and will pass through a filter. Asphaltum dissolves precisely as chapapote does, and the solution is the ordinary asphaltum varnish. Albert Company's coal, when heated to 280° F., the turpentine becomes colored brown. Two hundred parts of the coal, in fine powder, heated two hours with one thousand parts of oil turpentine, and finally boiled, gave a brown fluid, the coal remaining undissolved, even after digestion two days. The brown fluid was decanted, another portion of turpentine added, and the whole again heated, and this repeated again, still left the coal undissolved. The coal was washed in strong alcohol, and dried at 400°, when it ceased to lose weight; 7 3-10 parts had been abstracted by the turpentine and heat. In another sample, treated in the

same way, one hundred parts lost 5 7-10 parts. In each case, about ten times the weight of coal, in turpentine, had been used. The brown matter alters the character of the turpentine, and the products are left by evaporation, in the form of a brown, brittle compound. The coal becomes softened by the digestion, but regains its former condition and appearance on drying.

In the definite action of oil of turpentine, the distinction betwen bitumens and coal is seen in the solution of the former, while only a small portion of bitumen is dissolved from the latter. When, instead of Albert Company's coal, we take Scotch cannel, a well characterized coal, the same brown solution is obtained by the use of boiling oil of turpentine. This partial action of turpentine, shows a resemblance between these two coals.

Action of Benzole.—This substance, as derived from the destructive distillation of coal, is an excellent solvent of bitumens. Both chapapote and asphaltum are dissolved in it, with or without heat, into uniform red-brown fluids, which pass the filter. Albert Company's coal gives, as in the case of turpentine, a brown colored compound to this fluid, while the coal remains undissolved. By using three portions of the fluid on the same coal, the third solution, even after boiling, is nearly colorless, and nearly the original quantity of coal remains.

Action of Rosin Oil.—In the distillation of rosin, this product is obtained as a light yellow-colored oil. It dissolves bitumens, and forms, with chapapote and asphaltums, clear, brown, heavy varnishes.

Albert Company's coal gives, as in the case of turpentine, a brown color to the oil; the first and second portions being removed after digestion, the third becomes only slightly colored. The coal, after being washed and dried, exhibits its ordinary appearance.

Action of Linseed Oil.—This substance is used in the arts for dissolving asphaltum; its action on chapapote is the same, forming with both a brown varnish, in which all these bitumens disappear.

Albert Company's coal. The oil in this case was heated to 300° F., some time on the coal, no alteration took place in either. Some fragments of tin were added, and the temperature raised until the tin was fluid; after some hours the oil had suffered the same changes as attend heating it, while the coal remained unaltered.

Action of Sulphuric Ether—This solvent of oils dissolves chapapote and asphaltum, as it does other bitumens. Its prolonged action on Albert Company's Coal, causes the solution of a naphtha-like fluid and a resinous body; the coal remains softened, but regains its original appearance by drying.

The action of these solvents affords the strongest evidence of the mineral of the Albert Company's mine being not only coal, but bituminous coal, well characterized. All the bituminous coals yield, to one or more of these, some portion of their more inflammable parts.

Action of Nitric Acid, sp. gr. 1.20.—Chapapote, when warmed in this acid, colors it, swells, and at 212° F. is converted into a porous, coke-like mass, which, at a higher temperature, decomposes the acid. Asphaltum exhibits nearly the same action, more humus, or tannic acid being produced. Albert Company's coal, heated to boiling point of the acid, it exhibits no change, the acid is not decomposed.

Action of Sulphuric Acid, (50 *Oil Vitriol*, 50 *Water.*)—Chapapote melts in this acid, at 214° F, into an adhesive balsam. Asphaltum melts

at 217° F., in this acid, gives vapors of petroleum, and combines slightly with the acid. Albert Company's coal, digested in the acid at 214° F., suffers no alteration; at 250° F., no change is produced on the coal or acid.

Action of Oil of Vitriol.—Chapapote melts in oil of vitriol, at about 214° F.; at a higher temperature, colors the acid black, and is decomposed. Asphaltum melts, chars and blackens the acid, leaving a brown mass.

Albert Company's coal, heated to 300° F., in oil of vitriol, undergoes no change. At 450°, bubbles of gas escape from the pores of the coal, and the structural lines become developed; no swelling or tendency to melt or form coke is exhibited. At near 600° F., the acid is decomposed, sulphurous and carbonic acids escape as gases. On cooling the acid, its color remains unchanged. This is a character which distinguishes coal.

These are some of the many trials which have been made, and among them no result has been obtained showing a correspondence between chapapote, asphaltum and Albert Company's coal; but the more they are multiplied, the stronger the points of diversity become prominent.

The chemical relations of these bodies, are deemed the strictly important ones, as they depend on the composition of the matter from which each was formed originally. They in fact make up the whole valuable properties of these substances, when we include the influence of heat.

Considered geologically, physically and chemically, the Albert Company's coal is entirely a different natural product, from either chapapote or asphaltum. It is a highly bituminous coal, and has its place in a systematic arrangement, near to cannel coal.

In its destruction by burning, the Albert Company's coal presents indications of its origin from cellular tissue, in the small proportion of ashes afforded by a given weight. Thus, 100 parts of different samples give from 0.54 to 1.30 per cent. of snuff-brown colored ashes. This small amount belongs to a peculiarly pure organic matter only, and is a character of some importance, in connecting this with other more dense coals. Taking the purer European coals, we have the Alais Rochelle, sp. gr. 1.322, affording 1.41 per cent.; Commentry, sp. gr. 1.319, 0.24 per cent.; Rive de Gier, Grand Croix, sp. gr. 1.302, 1.44 per cent.; common coal, Obernkirchen, sp. gr. 1.279, 1 per cent.; coal of St. Columbe, sp. gr. 1.305, 0.89 per cent.; Westphalia, sp. gr. 1.288, 0.70 per cent.; Konigsgrübe, sp. gr. 1.285, 0.60 per cent., &c.

It is also a remarkably dry coal, 100 parts exposed to a temperature of 400° F., lose only 1 per cent. of moisture.

As a material for manufacturing gas, either with other kinds of coal, or alone, this coal has a high value. Its application as an aid in kindling fuel of difficult combustion, and in mixture with other coals, for making a cheerful fire, will add greatly to our resources of this article of necessity, in New England.

It is probable, too, that its uses in the arts, as the basis of black paints and cements, will extend, as its introduction increases.

Respectfully,

AUG. A. HAYES,

Assayer to State of Massachusetts.

1 Pine St. Boston, 15th Sept., 1851.

REPORT OF DR. JAMES R. CHILTON, NEW-YORK.

I HAVE analyzed the sample of coal from Hillsboro', N. B., which you left with me, and I find it to be a highly bituminous variety. It yields, by analysis, the following:

Volatile matter,.....	58.48
Fixed carbon,.....	40.86
Ashes,.....	0.66
	100.00

Some time in June last, I analyzed this same article for Dr. Gesner; the result of that analysis was about the same as the above. The article was at that time put into my hands under the name of "asphaltum," and I so designated it in the statement given to Dr. Gesner. The external appearance of the article being such, as not to lead a person to doubt that it might be asphaltum, and the object of the analysis then, was only to determine the proportions of volatile and fixed matter, to show its utility for gas manufacture. In this respect, it bears a strong resemblance to asphaltum and some varieties of cannel coal.

By numerous experiments, which I have recently made with the article, I find that it does not possess those properties which distinguish asphaltum from coal. Asphaltum dissolves very readily in oil of turpentine, naphtha, chloroform, &c., and forms a thick solution, which is used for a varnish. The Hillsboro' coal does not dissolve in either oil of turpentine, naphtha, or chloroform, even when boiled with them. The liquids, under these circumstances, become a little discolored, which is owing to the coal yielding a small portion of its excess of bitumen.

When asphaltum is held against a piece of heated iron, it melts readily, like common rosin; while the coal in question, similarly treated, does not melt at all, nor does it become more softened than some other kinds of bituminous coal.

In adition to the foregoing, I may state that I have examined some of the shale, said to be from the walls of this coal-bed, at Hillsboro', which has portions of the coal adhering to it. I find it to be a true coal shale, containing organic vegetable structure.

Yours, respectfully,

JAMES R. CHILTON, M. D., *Chemist.*

NEW-YORK, April 13, 1851.

REPORT OF GEORGE C. HUDSON, OF LIVERPOOL.

THIS sample is a true jet coal, or lignite; specific gravity, 1.091. Upon being subjected to dry distillation, (as in the ordinary of gas making,) it yields 61 per cent. of inflammable gases, of high illuminating quality, leaving 39 per cent. of light gray, silvery coke. It is entirely free from any contamination by sulphur, and on this account, and the comparatively low

temperature required for the elimination of the gaseous products, I am of opinion that it would be admirably adapted for the purpose of gas illumination. It might be objected, perhaps, that its low specific gravity, and consequent bulky form, would be a hindrance to its use for gas purposes; but when *the slight degree of purification*, which would be required for the gas, and the capability of a more frequent charging of the retorts, owing to the facility with which it parts with its gaseous components, are taken into account, the objection to its lightness and bulk must fall to the ground. The purity of the coke is such, that it might be advantageously used in the manufacture of steel. It is quite distinct from the substance called asphaltum. It is not affected in consistence by a heat of 212°, whereas asphaltum is partially liquefied in boiling water. It (the jet) is scarcely soluble in ether, and is intact in pure alcohol; it is scarcely affected by turpentine, or any of the essential oils, and is only acted on, to a moderate extent, by pure coal naphtha, or distilled oil of petroleum, whereas asphaltum is more or less soluble in all these agents, and in the latter, (oil of petroleum,) especially, it is entirely dissolved. The mean gravity of asphaltum is higher, being 1.160. The jet coal, under notice, would be applicable to many ornamental uses, but its chief utility resides in its gas affording properties, for which it should meet a ready sale.

GEO. C. HUDSON,

Consulting and Analytical Chemist.

LIVERPOOL, April 24, 1851.

REPORT OF DR. URE, OF LONDON.

LONDON, 24 BLOOMSBURY SQUARE, 14th March, 1851.

I hereby certify, that the shining, black, solid pieces, which you put into my hands this morning, are lumps of pitch coal, a true mineral of the geological coal formation, and therefore, in every sense of the term, popular, scientific, and legal, a truly mineral production or substance.

I am truly yours,

ANDREW URE, M. D., F. R. S.

REPORT OF DR. JOHN TORREY,

Professor of Chemistry, &c., College of Physicians and Surgeons of New-York.

I HAVE examined, with much care, a specimen of mineral combustible matter left with me by Messrs. Cook & Smith, of New-York, and said to have been found in Hillsboro', New Brunswick. It is my decided opinion that this substance is a highly bituminized coal. It differs from asphaltum, in not being fusible, the heat merely causing it to swell, as it does some of the varieties of bituminous coal. It is likewise insoluble in spirits of turpentine, even at a boiling heat; whereas asphaltum dissolves readily in the fluid. This new variety of coal is remarkable for the large quantity of volatile matter which it contains, nearly equal to 60 per cent., while

the quantity of ash left when it is perfectly burned, amounts to less than one per cent.

JOHN TORREY.

LABORATORY OF THE COLLEGE OF PHYSICIANS AND SURGEONS,
NEW-YORK, March 13th, 1851.

REPORT OF PROFESSOR JAS. C. BOOTH,

Assayer of the United States Mint, &c., at Philadelphia.

PHILADELPHIA, April 4, 1851.

I HEREBY certify, that I have carefully examined the bituminous coal from Hillsboro', New Brunswick, which I received from Messrs. Cook & Smith, through Dr. James R. Chilton, of New-York. It contains in 100 parts, 1.75 water, which passes off at 212°; 59.75 volatile matter, at a red heat; 38.25 of fixed carbon, and 0.25 of ash;—the two last making 38 1-2 per cent. of a porous coke. It is shown to be bituminous coal, and not asphalt, because it has a similar composition to some English bituminous coals, and, like them, swells up in coking, without a true fusion; because it is insoluble in boiling alcohol, oil of turpentine, and pure mineral naphtha, and only a trace of it is soluble in boiling ether; and because the products of a careful distillation are different from those of asphalt. I have carefully compared it in all these points, with asphalt from the Dead Sea, or that asphalt from which that substance derives its name and characteristics, and have found it different from it in all.

JAS. C. BOOTH,

Professor of Chemistry applied to the Arts,
University of Pennsylvania.

REPORT OF DR. FREDERICK PENNEY, OF GLASGOW.

GLASGOW, 16th April, 1851.

IN compliance with your request, I have made a general chemical examination of the mineral substance which you placed in my hands, and which you stated to be coal from Hillsboro', Albert county, New Brunswick. My attention and experiments were directed exclusively to the solution of the question, whether this substance is coal or bitumen? I beg now to report briefly that I have completely satisfied myself, by a series of unexceptionable experiments, that the present mineral is a mixture of true coal and bitumen, in the proportion of 76.2 per cent. of coal, and 23.8 per cent. of bitumen. It must, therefore, be regarded as a highly "bituminous coal," and certainly a true mineral.

In its appearance, as well as in some of its physical characters, it differs strikingly from the common coal of Great Britain. It is remarkably light, having the specific gravity of 1.097, which is the lowest density of any coal I have had occasion to examine.

A thorough analysis of it gave me the following results :—

Coke.	Volatile matter,	61.0
	Pure coke,	38.5
	Ash,	.5
		100.0

It would yield a large proportion of very fine and rich gas for the purpose of illumination, and much more than the cannel or gas coal of Scotland and England. It is perfectly free from pyrites, and hence the gas produced from it will not contain any injurious "sulphur ingredients." In coking, this coal swells very considerably, and the coke takes the form of the vessel in which it is made. The coke is extremely *friable*, and from its want of compactness it is, in my opinion, of inferior quality. The amount of incombustible ash contained in it is exceedingly small, and quite insignificant.

Trusting that the above will be, in the mean time, a sufficient answer to your inquiry,

I remain, sir,

Yours, very faithfully,

FREDERICK PENNEY,

Professor of Chemistry.

REPORT OF ROBERT FOULIS, ESQ., OF ST. JOHN, N. B.

I CONSIDER the mineral found at the Duffy mine, in Albert county, N. B., now in the possession of Mr. Allison, to be a very pure bituminous coal. I designated it as asphaltic coal, merely from its containing a greater portion of bitumen than is common to the ordinary coal in use, and a less portion of earthy matter than is usually found in most kinds of pit coal, causing it to have a smaller specific gravity.

I have found it, on analysis, to contain the same constituents that are essential to common bituminous coal, namely—carbon, hydrogen, oxygen and azote. It is found, as to its geological position, in a coal formation, and encased in a true coal shale. Unlike asphaltum, it does not melt at the temperature of 212°; nor does caustic potash dissolve the notable quantity of this coal that it does of asphaltum. Neither does the action of oils, petroleum, or sulphuret ether furnish the same products with this coal, that these substances do when united with asphaltum.

Like true coal, (when found at some depth,) this mineral has a regular and distinct cleavage of a lamellated character, which quite distinguishes it from asphaltum, which has a massive or continuous form. Atmospheric action produces little or no effect on asphaltum, but on this coal it produces a rapid division or falling to pieces of the mass. I have, therefore, no hesitation in declaring the coal in question to be a mineral substance, quite different from the true asphaltum found in Lake Asphaltum, and imported from India. I consider it to belong to Professor Jameson's third species, in his mineral arrangements of coal, and to be allied to the sub-species called by him pitch coal.

ROBERT FOULIS.

ST. JOHN, N. B., 6th March, 1851.

REPORT OF DR. B. SILLIMAN, JR.,

Professor of Chemistry.

NEW-YORK, Oct. 7th, 1851.

MESSRS. COOK & SMITH, New-York:

Gentlemen:—I have read, with pleasure and attention, the report of Mr. A. A. Hayes to your company, concerning the Albert Company's coal, of New Brunswick, dated Boston, 15th September.

The results of Mr. Hayes are entirely satisfactory and irrefragable—to the point that the material in question *is truly a coal* of the bituminous class, and in no sense whatever can it be regarded as asphaltum or bitumen. Every chemist who gives the subject his attention, must admit that the chemical proof brought forward by Mr. Hayes, and sustained by a constant comparison of the Albert Company's coal with true bitumen and asphalt, when treated by the same methods and reagents, are entirely convincing, and forever settle any doubt which a supposed similarity of general appearance, fracture, &c., may have countenanced as to the *identity* of said coal, and the other substances in question. I see no reason to alter the opinion expressed in my certificate of last February, regarding the constitution of the said coal.

Respectfully,

B. SILLIMAN, JR.

FROM PROFESSOR B. SILLIMAN, SEN., OF YALE COLLEGE, NEW HAVEN.

NEW HAVEN, CONN., Oct. 13, 1851.

I HAVE seen specimens of a shining black mineral, with a conchoidal fracture and bright lustre, which is said to come from Hillsboro', in New Brunswick. This mineral is, in my opinion, bituminous coal, of excellent quality and great purity. It takes fire when held in the flame of a candle, and burns brilliantly, with the escape of much smoke, but it does not run or melt, but leaves a bulky and light coke, of a tender quality. Asphaltum or bitumen, so treated, would melt at a temperature much below the point of inflammation, and would consume entirely when burned, having only a light ash and no coke. The opinions of Dr. C. T. Jackson, and of Dr. James G. Percival, as to the geological relations and position of this mineral, and the scientific value of the fossil plants and animals associated with it, as well, also, as the opinion of A. A. Hayes, Esq., regarding its physical and chemical characters, I should regard as entirely trustworthy and final—such opinions being based, in each case, on a personal examination of the locality and mineral, and an elaborate study of the evidence.

B. SILLIMAN, SENIOR.

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