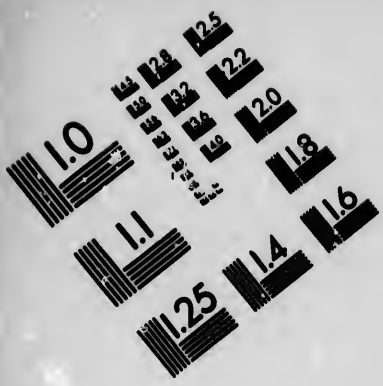

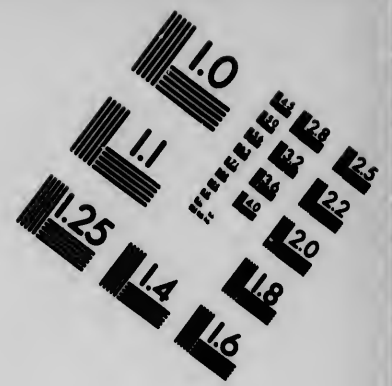

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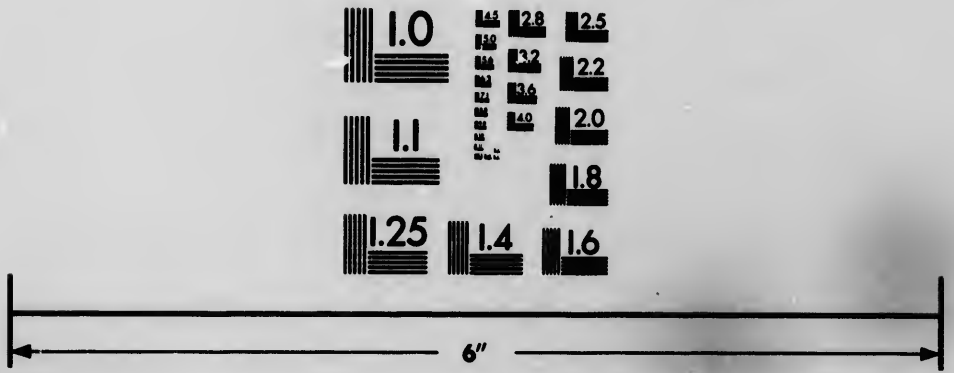

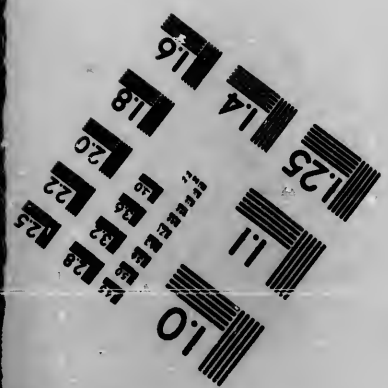

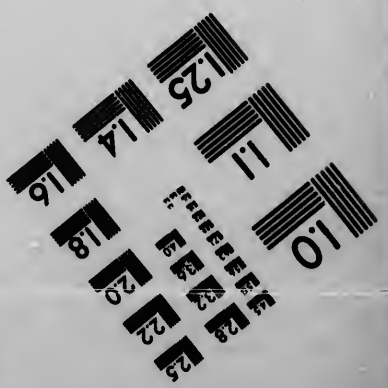

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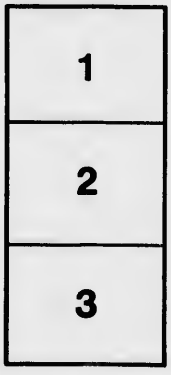

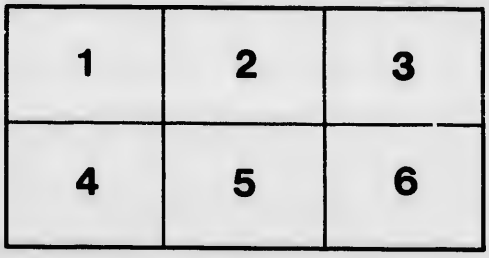

GEOLOGICAL SURVEY OF CANADA.
ALFRED R. C. SELWYN, DIRECTOR.

REPORTS

OF

SIR W. E. LOGAN, F.R.S., F.G.S.,

ERRATA.

Page 45, twenty-third line from top, for "Pictou, Mining Company," *read* "Montreal and New Glasgow Coal Company."

Page 47, twelfth line from top for "remarkable" *read* "remarkably."

The first formula on page 112 should read :—

$$\left(\frac{C \times 13268}{965.7}\right) + \left(\frac{H - A \times 62470}{965.7}\right) = x$$

the sign + having been omitted between the first and second quantities of the first term.

Page 129, eleventh line from the bottom, for "Specific gravity 17.65," *read* "1.765."

In the table facing p. 146; in the first line of the "GENERAL NOTES AND REFERENCES," for "first (right) column" *read* "first (left) column."

Page 171, third line from top, for "1860" *read* "1869."

Page 182, ninth line from top, for "than any Provincial coal," *read* "than that from any Provincial coal."

Page 185, seventeenth line, for "south-west" *read* "south-east."

From the Reports of the Geological Survey of the Dominion of Canada for 1867-69.

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1870.

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GEOLOGICAL SURVEY OF CANADA.

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REPORTS

OF

SIR W. E. LOGAN, F.R.S., F.G.S.,

LATE DIRECTOR OF THE GEOLOGICAL SURVEY,

AND

EDWARD HARTLEY, F.G.S.,

MINING ENGINEER TO THE GEOLOGICAL SURVEY,

ON A PART OF THE

PICTOU COAL FIELD,

NOVA SCOTIA,

WITH AN APPENDIX ON

COALS AND IRON ORES,

AND A

GEOLOGICAL MAP.

From the Reports of the Geological Survey of the Dominion of Canada for 1867-69.

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1870.

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MAP ACCOMPANYING THIS REPORT.

Geological Map of the Pictou coal-field, in the Province of Nova Scotia, by Sir William E. Logan, F.R.S., and Edward Hartley, F.G.S. Scale one inch to one mile. Engraved on copper and printed in colours.

GEOLOGICAL REPORT,

FOR 1867-1868,

BY

SIR W. E. LOGAN, F.R.S., F.G.S.,

LATE DIRECTOR OF THE GEOLOGICAL SURVEY,

ADDRESSED

TO THE HONOURABLE JOSEPH HOWE, M.P.,

SECRETARY OF STATE FOR THE PROVINCES.

MONTREAL, 20*th December*, 1869.

SIR,

In May last I had the honour of presenting to the Government a Summary Report of the Progress made in the Geological Survey for the years 1867-1868, stating that there had just before that time been received from my various assistants detailed reports of their work, which would be transmitted after due study had been devoted to them. Summary Report, 1868.

Of these detailed Reports, I have now to transmit to you by the hands of my successor, Mr. A. R. C. Selwyn, the Report of myself and Mr. E. Hartley, on a portion of the coal field of Pictou, Nova Scotia; that of Mr. J. Richardson, on the Lower Silurian rocks occupying the south side of the St. Lawrence, between the Chaudière and the Rivière du Loup, in the Province of Quebec; that of Mr. H. G. Vennor, on the Laurentian rocks of the counties of Addington, Hastings and Peterboro, in Ontario; that of Mr. C. Robb, on the deposits of a region comprising chiefly the counties of York, Carleton and Victoria, in New Brunswick; and the Report of Dr. T. Sterry Hunt, on various points of geological and chemical economics. Detailed Reports.

To these Reports are added one by Mr. R. Bell, on the rocks of those islands of the Manitoulin group which are situated to the west of the Grand Manitoulin. This Report embodies the results of an exploration made in 1866, the mention of which was accidentally omitted in the Summary Report.

REPORT

ON A PART OF THE PICTOU COAL FIELD, NOVA SCOTIA.

Pictou coal field.

It has already been stated in the Summary Report of May last, that the portion of the Pictou coal field to which the time of Mr. Hartley and myself was devoted in 1868, was that which lies southward of New Glasgow, and extends several miles on each side of the East River; and that while the examination of the west side was wholly committed to Mr. Hartley, that on the east side was undertaken by myself. During the season which has just passed however, Mr. Hartley has added many facts to those previously collected by myself on this side, and these will now be embodied with my own.

Acknowledgments for assistance.

All the more important collieries in active operation near New Glasgow, are situated on the west side of the river; and it will be observed by Mr. Hartley's Report that he has had to thank the managers of these collieries for the ready assistance they universally afforded him in facilitating his work, by pointing out facts of interest, and supplying him with plans shewing under-ground excavations and topographical details on the surface. I have to express my obligations also to many persons for information, both oral and documentary, on the east as well as the west side of the river, and among them are Mr. J. B. Moore, Mr. J. P. Lawson, Mr. R. G. Haliburton, Mr. L. R. Kirby, Mr. Alex. McKay, Col. R. B. Sinclair, and Mr. J. R. Jackson. Mr. J. Rutherford, the Provincial Inspector of Mines, amongst other important information, obliged us with written descriptions of the boundaries of the various coal areas which have been leased by the Provincial Government; Mr. W. A. Hendry, Deputy Commissioner of the Crown Land Department, was so kind as to present us with a manuscript map shewing the positions of these areas and their proximate relations to some of the topographical features of the country, and Mr. H. Y. Hind supplied us with chain measurements of some of the roads and rivers. We are indebted to Mr. Jno. Weir and Mr. Alex. McBean, practical colliers, for pointing out to us various local facts of an important character with which they had become acquainted in the course of their experience; Mr. Thos. Lawther, by permission of Mr. Daniels of the Marsh Colliery, supplied us with information of the same kind, and all the farmers and inhabitants of the country were found to be most ready to assist us as far as they could.

The structure of this part of the Pictou coal field is of a very complicated character. While it is much covered with drift, it is disturbed by

undulations and broken by important faults, and to acquire even a proximate knowledge of the arrangement of its strata it was found necessary to measure, by compass and pacing, almost all public and private roads, as well as footpaths and streams. In constructing a map of the district, these have been kept in place by their relations to such of the straight boundary lines of the areas as we have had an opportunity of following; which lines, as given by Mr. Rutherford, have been assumed to be correct both in bearing and length. We have taken the coast and the navigable parts of rivers, as given on the Admiralty charts; and with a view of further binding our work together, Mr. W. B. Leather, C. E., was employed to measure, by theodolite and chain, a line from the East River to Sutherland's River, the direction being from the New Glasgow bridge on the former, by the old Merigomish road over Fraser's Mountain, to the lowest bridge on the latter. Mr. Leather has further assisted us by furnishing other lines, which he has had occasion to measure by theodolite, on both sides of the river. From these elements we have endeavored to construct a map on the scale of twenty chains to an inch. This may be presented at some future time; in the meanwhile its place is supplied by a plan on the scale of an inch to a mile, for the purpose of explaining the structure.

Measurements by Mr. W. B. Leather, C.E

In the limited district in which we have worked there appear to be rock masses of four distinct horizons, more or less proximate. These are in ascending succession:

Series of formations.

1.—Conglomerates, quartzites and compact slates, (Devonian.)
2.—Greenish-gray and red sandstones, with conglomerates and impure limestones.
3.—Red coarse conglomerates.
4.—Productive coal measures.

(Carboniferous.)

1. CONGLOMERATES, QUARTZITES AND COMPACT SLATES.

Pre-carboniferous rocks.

On the east side of the East River, about four miles southward of New Glasgow, there rises a hill which runs eastward to Sutherland's River, and is transversely cut into two parts by the valley of McLellan's Brook. Of these the western is called Weaver's or McGregor's Mountain, while the other is termed McLellan's Mountain. Rocks of the series about to be described probably compose both hills, but it is in the last named that they have been observed by me. No exposure has been met with which gives all the members of the series in regular succession, nor is it certain which is the upper and which the lower part of what has been examined, the dip being always very obscure. On the north flank of McLellan's Mountain there is met with, belonging to this series, a dark leek-green slate, in some places compact, as on the south side of St. Mary's road, about 750

McGregor's Mountain.
McLellan's Mountain.

Green slate.

paces southward of the house of Mr. Donald McLean (John's son), on a small mountain stream. A similar green slate is seen on Sutherland's River, at Park's Mills, but much of it is of a scaly character; and it is conspicuous from the opaque white surface it presents when weathered.

Quartzites.

On the same side of the hill, light and dark gray or nearly black, as well as olive-green quartzites, occur in several places, and a good instance of them presents itself at the bridge over a tributary of Sutherland's River, crossing the road already mentioned about half a mile from McPherson's mills.

At the edge or brow of the hill, south of the house of Mr. Finlay McDonald (John's son), and near the mountain road, a rock of a greenish colour is composed of feldspar with fine grains of quartz; loose angular masses of an epidotic character lie about, and some of a porphyroid aspect, reddish in tint, holding epidote and disseminated small masses or crystals of white feldspar. Some angular fragments of the rock shew a purplish slate attached to them, and flakes of a bluish slate are enclosed in the rock in place. In some parts there appeared to be an obscure indication of stratification, the dip being N. 13° W. $<40°$*; but the beds are so closely soldered together as to be undistinguishable except by slight differences of colour on the weathered surface. The rock here has different planes of cleavage, the underlie of one set being S. 3° E. $<61°$, and of another S. 63° E. $<69°$.

Red conglomerates of McLellan's Mountain.

In several places between this and McLellan's Brook the ridge of the hill presents a firm reddish conglomerate, with an arenaceo-feldspathic base, enveloping pebbles of various sizes up to an inch in diameter, of white, reddish and yellowish quartz, with others of a Venetian-red jasper and indurated slate, and many of white feldspar. The rock is strong and hard, and does not disintegrate rapidly in the weather, but the pebbles are very distinct on weathered surfaces. The rock is of this character on the summit, behind the residence of Mr. Alexander McLean, sen. On the summit, about three quarters of a mile west, it is composed of the same materials; but it is somewhat paler in colour, from the presence of more feldspar, and it appears to be finer grained.

---

* The bearings in this Report are given in relation to true north, the variation for magnetic north being 23° 15′ to the west. Practical colliers and others accustomed to use compass bearings only are particularly requested to keep this in mind, as otherwise they may be perplexed at finding the bearings in the Report so different from what they might expect. Magnetic bearings are not adopted, because these change annually, the change at present being an increase of 0° 7′ a year.

It is to be regreted that the boundary lines of the coal areas have all been run by compass instead of astronomically; the consequence is that to follow them it is necessary to know not only the original bearing of the line, but the year when the survey was made. In old surveys the difference is such that without knowing the date, which is never stated on the plans in general use, it becomes a matter of great difficulty to trace the lines on the ground, particularly through swamps and parts encumbered with brush-wood.

At the western end of McLellan's Mountain, near the residence of Mr. Robert Campbell, much of the rock is a dark gray or blackish fine grained grit, with a rough exterior and trappoid aspect; while some of it is a fine grained pistachio-green altered sandstone, with a ragged earthy fracture and gritty surface. Associated with this is a mottled green and flesh-red felsite, holding epidote, and a granular feldspathic rock, opaque white and crumbling in weathered parts, while it is much veined with white quartz. Felsites.

Beyond this, southward, the rock becomes a coarse conglomerate of a mottled red and green, in some parts reddish-black, and chocolate-red in others. Some of the inclosed masses are six inches in diameter, composed of moderately coarse grains of a reddish and white feldspar and translucent quartz, with brilliant points, which seem to be micaceous specular iron ore. Some of the pebbles weather to a brick-red and orange-vermillion, very brilliant when wet. The whole rock is cracked in all directions, in fact brecciated. The sides of the cracks and the surfaces of some of the quartz pebbles are unctuous from a coating of specular iron ore. Some of the cracks shew slickensides, and some are filled with a brown manganesian powder. Coarse red conglomerates.

Not only was this conglomerate brecciated, but so was every mass of all the series wherever met with, and to such an extent that, after hundreds of attempts, not one specimen could be dressed into an oblong shape of four by six inches, some blow of the hammer always shivering it in unexpected directions into irregular fragments, from concealed cracks. Brecciated rocks.

In the locality last named, the coarse brecciated conglomerate is followed on the south side by a south-dipping band of limestone, which has been quarried for 120 paces on the strike, near the house of Mr. Alex. Fraser. The limestone exhibits fossils, one of them being *Spirorbis carbonarius*, and belongs to the succeeding series; and there may be some doubt whether the coarse conglomerate should not be classed with it. But including this conglomerate, the older rocks have here a breadth of 650 yards, and are limited on the north by the productive coal measures, dipping northward. Limestone.

No evidence was observed by me, on McLellan's Mountain, to shew to what epoch these older rocks belong; but masses somewhat similar are noticed by Mr. Hartley on the west side of the East River, in a position where they have been mentioned in his *Acadian Geology* by Dr. J. W. Dawson, who considers them to be of Devonian age, and on his authority they will be so distinguished.

2. GREENISH-GRAY AND RED SANDSTONES WITH CONGLOMERATES AND IMPURE LIMESTONES.

This series of deposits appears to constitute a part of those which in his classification of the section examined by me at the Joggins, on

the Bay of Fundy in 1843, and published in the first of the Canadian Geological Reports in 1845, Dr. Dawson, in his *Acadian Geology*, has called the Millstone Grit, corresponding, though somewhat different in aspect, to the Bonaventure formation of Gaspé in the Province of Quebec, and to the Millstone Grit of England. On this side of the Atlantic it might appropriately be termed the Grindstone grit, as at the Joggins it yields, in large abundance, the excellent grindstones for which Nova Scotia is celebrated.

Millstone Grit.

Bonaventure formation.

Rocks at foot of Fraser's Mountain.

The largest spread of it observed by me on the east side of the East River, occupies a triangular area, of which the western apex occurs near the house of Mr. John Jack, at New Glasgow. From this, one side of the triangle runs along the south foot of Fraser's Mountain towards Merigomish Harbour, while the other has its course near the houses of Messrs. J. Mackay, Murdoch Ross, William Love and Alexander Fraser, and crossing Olden's road would reach Sutherland's River, above Ross's bridge, where the extremities of the base would be about two miles apart.

Limestone with fossils.

It was also observed on McLellan's Brook, south of the limestone mentioned as having been quarried near Mr. Alex. Fraser's. Of this band of limestone, which is shewn by its organic remains to belong to this series, the following is a descending section:

	Ft.	in.
Red flaggy sandstone of a free grit.....	2	6
Red arenaceous limestone, spotted with small masses of greenish limestone	0	6
Reddish striped nodular limestone, resembling a conglomerate of greenish limestone gravel having its interstices filled up with fine red sand...	1	6
Reddish limestone of the same character, but holding more of the calcareous nodules, some of which contain *Spirarbis carbonarius*.....	3	2
Gray good limestone, in some parts mottled with red; it is compact in texture, and gives a conchoidal fracture. In a piece of limestone which had been quarried out of the bed, was observed a fragment of a spiral shell about half an inch broad at the base.....	11	0
Red arenaceous shale.....	1	0
	19	8

Limestone, McLellan's Brook.

The dip of this bed is S. 2° W. <42°. As already stated it has been quarried for about 120 yards on the strike, which would be N. 88° W. On the left bank of McLellan's Brook, about half a mile from the quarry, and about ten or eleven chains north of the point where this bearing would reach a sharp elbow of the stream, there occurs an exposure of gray limestone, which, although at one part in contact with red shale or slate, does not afford the means of clearly deciding its attitude or associations. Being without fossils, it was not found possible to make out whether or not it was the same bed as the one above described or one enclosed in the older red rock. As far as I could judge, the dip appeared to be N. 22° E. <68°, and the thickness about seventeen feet.

Farther up the brook, about thirty-three chains in a straight line, there occurs another calcareous band, which, with its associated strata, dips S. 1° E. <44°–54°. A descending section at the spot is as follows: Limestone McLellan's Brook.

	Ft.	
Red sandstone of free grit, interstratified with layers of red shale	15	Red sandstone.
Red sandstone of a free grit	15	
Red sandstone interstratified with thin bands of gray limestone, weathering to a straw-yellow	9	
Gray limestone with interstratified yellow-weathering calcareous layers	4	
Gray compact limestone with a conchoidal fracture	8	
Red sandstone and red shale	45	
	96	

Though no fossils were observed, it is not doubted that these strata are Millstone Grit; but it is not so certain with what series to class the rocks between this calcareous band and the one farther down the stream. Of these intermediate rocks there are three exposures, with intervals of concealment. They all consist, more or less, of a brecciated red and green coarse conglomerate, similar to that north of the limestone near Mr. Alex. Fraser's. Some of the inclosed masses are a foot in diameter, and among the smaller masses was observed one consisting of reddish orthoclase feldspar, with cleavable faces of an inch in diameter. Some parts of the exposures consist of red jaspery, fine-grained, argillaceous sandstone, harder than the usual strata of the Millstone Grit series, and others appeared to be a jaspery slate. The brecciated character of all these exposures makes it extremely difficult to determine the dip; but that of a bed of slate within seven chains of the more northern band of limestone seemed to be N. 37° E. <37°. If the brecciated rocks between these limestones, and the brecciated conglomerate north of the limestone near Fraser's both belong to the Devonian series, there would appear to be a dislocation running along the valley of McLellan's Brook in this part, the conglomerates of the brook being more to the south than those near Fraser's. Brecciated red and green conglomerates.

At a bridge about a quarter of a mile above the southern band of limestone, red sandstones of a free grit, computed to be about eighty feet thick, and belonging to the Millstone Grit dip N. 61° W. <20°, and show the irregular arrangement of the strata.

In the already mentioned triangular area of this formation, which is overlooked by Fraser's Mountain, the most continuously exposed mass of strata observed was in the channel of Pine-tree Brook, between the property of Mr. James A. Fraser and Pine-tree Gut. The total thickness of this mass may be about 1,000 feet. The lower part appears to be a greenish-gray sandstone of a grindstone grit, interstratified with several bands of nodular limestone, by the people of the country, from its impurity, called *bastard limestone*, none of which appeared to be fit for burning. There Pine-tree Brook. Impure limestones.

may also be interstratified, in concealed intervals, some bands of red sandstone, but no indications of these were observed.

Greenish-gray sandstones.

As an example of this lower part, an exposure on Mr. Jas. A. Fraser's land may be taken, where, between two bands of impure nodular limestone, dipping N. 7° E. $<34°$, the lower about eighteen inches and the upper about three feet, there is included 270 feet of greenish-gray freestone of an even grain, well suited for building purposes. The rock appears to be composed of fine grains of whitish quartz and whitish feldspar, with small disseminated grains of a black colour, the composition of which is uncertain. Some of the beds are marked by circular spots of different sizes up to a foot in diameter, which appear to be sections of sub-globular forms, containing a good deal of calcareous matter. These are of a lighter gray than the surrounding stone, and though much harder, yield more readily to the solvent power of the weather, and therefore present slight depressions, which wherever several small spots are together, give a fretted aspect to the surface. The proprietor calls them *bulls' eyes*. In the strike of the upper calcareous band a sink-hole was observed, the bottom of which, though dry, appeared to be lower than the level of the neighbouring brook.

About a third of a mile down the brook there is another exposure about ninety feet above this. It consists of the same sort of greenish-gray freestone, and with a thickness of about 130 feet is surmounted by another band of impure nodular limestone of eight inches, supported by a couple of feet of a light gray calcareous sandstone, similar in aspect to the material of the *bulls' eyes*. Farther down the brook, and about 100 feet higher in the series, there is another mass of greenish-gray freestone of about twenty feet, which has been quarried, to a small extent, for building stone. The whole of these beds, making about 600 feet, have in the distance of more than half a mile a pretty regular average dip of N. 2° E. $<33°$, and occupy a breadth of about thirteen chains.

Pine-tree Gut.

At the junction of this brook with Pine-tree Gut, on the left side of the stream, what is called Pine-tree Bank, a wooded cliff of about fifty feet in height, presents at the base about fifteen feet of gray freestone in massive beds of from three to five feet thick. A quarry has been opened in it about seven feet above the level of the water. The quarry stone has a face of six feet, and there are eighteen inches in the middle which would yield good flagstones, while the remainder would furnish building stones of excellent quality. In the cliff above this, thick bedded red sandstones occupy twelve feet, and red shale or marl and red flaggy sandstones about twenty feet more. At the edge of the cliff, a few feet above this, there was pointed out to me by Mr. J. Weir a layer of about an inch thick, which it was supposed might be a coal seam; but observing it had beneath it a bed of sandstone, without any indication of *Stigmaria*, a

Gray and red sandstones and shales.

close examination shewed that it was only a layer of drift plants, the bark of which had yielded the coal. A band of impure nodular limestone was obscurely seen above it. The dip is here N. 33° W. <14°. Drift plants.

What is supposed to be a continuation of the gray freestone at the foot of the cliff, occurs about twenty-five chains to the eastward, on the telegraph road, at the bridge over the south branch of the brook, where a flagstone quarry, formerly worked, became covered up in the construction of the road. A bed of impure nodular limestone underlies the rock a few feet, and it appears probable that the old quarry here may occupy the same horizon as that at the summit of the series of beds already described further up Pine-tree Brook.

North of the old quarry, and eighty or a hundred feet above it, the interval being made up apparently of the red rocks of the upper part of Pine-tree Bank, and additional strata of the same character, another band of greenish-gray freestone, fit for building purposes, occurs on the land of Mr. J. Weir. It is probably between twenty and thirty feet thick, and is succeeded by red sandstones and shales, which occupy the channel of Pine-tree Brook up to the dam of Weir's mills. These red strata, about 200 feet in thickness, are succeeded on the road, close by the mill-pond, by a few feet of greenish-gray sandstone, with another band of impure nodular limestone. The whole series of strata thus described on the lower part of the brook, occupies a breadth of about twenty-eight chains, with an average dip of N. 23° W. <12°, giving a total thickness of about 400 feet. Pine-tree Brook. Weir's mills.

Proceeding westward, these upper strata gradually assume a dip eastward of north, and at the distance of about a mile in a straight line from Weir's mills, some of the red sandstones are seen on the telegraph road, dipping N. 7° E. < 31°, conforming well with the lower mass of strata in the vicinity of Mr. J. A. Fraser's, the breadth they occupy being somewhat diminished from the increase of slope. Here the upper beds come close upon the flank of Fraser's Mountain, composed of the conglomerates of the third series, towards which they dip all the way to New Glasgow. On Mr. A. McGregor's land, one of the bands of impure nodular limestone is seen at the foot of the hill, about eighteen chains north-eastward of the telegraph road, and the conglomerates of the hill crop out only a short distance north of it. A. McGregor's impure limestones.

Farther westward, much drift covers the surface, but within a mile of New Glasgow the presence of red sandstone was ascertained by Mr. J. P. Lawson in a trial-pit sunk twenty-nine feet through red clay, about thirty chains north-eastward of the old straight road running S. 63° E. from the Scotch Church. About twelve chains on the same side of this road, but more than a quarter of a mile nearer the church, greenish-gray freestone, in a shattered condition, occurs. It is overlaid by a band of impure nodular limestone, and at the junction there is a layer holding drift plants, Trial-pit on red sandstone.

chiefly *Calamites cistii*. But this exposure is on the south side of the narrowing triangular area, which comes to a point where another shattered exposure of the same freestone was met with at the foot of the rising ground on which the house of Mr. J. Jack is situated.

South side of triangular area.

On the south side of the triangle, upwards of a mile from the apex, still another shattered exposure of the greenish-gray freestone occurs, where this side of the triangle crosses the telegraph road. After an interval of about a mile and three-quarters, the next observed indication of the strata on this side is near the house of Mr. Murdoch Ross, where red sandstones are exposed with an uncertain dip. Farther on, red arenaceous strata were met with by Mr. W. Love in sinking a well near his house. Red sandstones are again seen on what is called the Pent road to the Marsh, at the foot of the hill descending from the house of Mr. Alexr. Fraser; but here also the exposure is obscure and the dip uncertain, and it is only on approaching Sutherland's River, near Ross's bridge, that the dip can be clearly made out from natural exposures, though the occurrence of red sandstones in place, is known in various trial-pits sunk on the St. Lawrence area by Mr. Haliburton.

Red rocks.

Section Ross's bridge.

At Ross's bridge the following descending section occurs, the upper part being above the bridge and the lower exposed in a cliff immediately below it:

	Feet.
Red sandstone	50
Measures concealed	90
Red and brownish-drab sandstone	60
Brownish-red sandstone	60
Red and greenish-yellow mottled sandstone	180
Greenish conglomerate, with pebbles of a whitish quartzite and greenish argillaceous sandstone, spangled with small flakes of mica; all the pebbles are green externally. This layer is of varying thickness, from three inches to	1
Red shale	7
Red sandstone	2
Green shale	2
Green crumbling sandstone in thin bands, separated by green shale or more crumbling sandstone	4
Red sandstone and red shale	16
Yellowish sandstone mottled with green and red	14
Red and green mottled sandstone	4
Greenish sandstone mottled with red	9
Red sandstone	9
Red shale	5
Red sandstone	6
	519

These strata occupy a breadth of nearly a quarter of a mile, with a dip which, upon an average, is S. 23° E. < 24°, and the same attitude may

extend some distance farther down Sutherland's River. The dip is the reverse of that at Weir's mills, and between these places there must thus be at least one anticlinal form, and possibly more; but whether any rocks lower than the Carboniferous are brought to the surface in the interval has yet to be ascertained. Anticlinal.

3. RED COARSE CONGLOMERATES.

At the bridge of New Glasgow is exposed a series of conglomerates, which, in general colour, are between a brick-red and chocolate or Indian-red, and whose inclosed masses, varying from the smallest pebbles to boulders of two feet in diameter, are, for the most part, unmistakably derived from the red and greenish-gray sandstones, red shales and impure nodular limestones of the rock last described, some of them containing the same vegetable organic remains. With these pebbles and boulders are associated a few from the rocks still lower down. The whole are inclosed in a matrix of the same mineral character, constituting an argillo-arenaceous cement, which is also calcareous, and in the interstices of the boulders and pebbles is often observed a network of white calc-spar aiding to keep them together. There are interstratified in the rock, bands, from a few inches to several feet in thickness, of fine red sandstone and red shale, which serve to give assurance of the dip, and these occur at such distances apart as to render the conglomerate beds thick and massive, their transverse measure varying from ten to some times nearly 100 feet. New Glasgow conglomerates.

To this rock Dr. Dawson has given the name of the New Glasgow conglomerate. From a point a short distance above the bridge, to one much farther below, these conglomerates have a breadth of very nearly a mile. with a dip, which on the average is N. 3°—13° W., with a slope gradually diminishing from 50° in the lower to about 30° in the upper part, and giving a total thickness of about 1,600 feet. As already indicated, this great mass of conglomerate composes Fraser's Mountain, towards the south flank of which, presenting the outcrop escarpment of the inferior part, the red and gray strata of the Millstone Grit dip in such a way as, without other evidence to induce the supposition that the one series overlies the other conformably. But on the west side of the East River Mr. Hartley has evidence to show that there is a want of conformity, at least in some places. Thickness.

Three miles eastward of New Glasgow these conglomerates have a breadth, between their base, east of the house of Mr. A. McGregor, and their summit, on a property formerly belonging to Mr. William Fraser (Moose) of about fifty-four chains, and they are here immediately and conformably overlaid by the following ascending section: Moose Fraser's Concretionary limestone.

Section.

	Ft.	in
Gray limestone which has been quarried for burning	20	0
Measures concealed	10	0
Bluish-gray slightly calcareous sandstone		5
Concretionary beds. Bluish-brown concretionary limestone, the surface of which presents concentric botryoidal thinly laminated concretions, with grayish and red clay in the interstices and inequalities		10
Gray and red clay		8
Reddish concretionary limestone, with concentric botryoidal laminæ as before	1	0
Whitish-gray limestone	1	0
Gray and red mottled clay, resembling fireclay	1	4
Gray flaggy sandstone	1	8
Gray clay		6
Whitish arenaceous limestone, holding abundance of *Spirorbis arietina* *	2	2
Grayish-blue, spotted, slightly argillaceous sandstone	1	0
Measures concealed, including several feet of underclay	24	0
Coal and black carbonaceous shale, including about eighteen inches of good coal at the bottom, which used to be mined by Mr. W. Fraser, for the purpose of burning the limestone in the lower part of the section	4	5
	69	0

J. Small's Concretionary limestone.

The dip of these strata is N. 10° W. <47°, and very nearly on the strike this would give, they are again met with on a brook on the property of Mr. James Small, on the road to Little Harbour, Merigomish. The one locality is as much as three miles from the other; but the botryoidal concretionary limestone layers in both are so peculiar and so strikingly like in appearance, and in their relation to an overlying seam of coal, that no doubt can be entertained of their equivalence. At Mr. Small's the dip

* This is a new species, obtained by Mr. Hartley, who, with Dr. Dawson and myself, visited the locality in August, 1868, and the following is a description of it, kindly supplied by Dr. Dawson. The figure is magnified thirteen diameters, the natural size being shewn at *a*.

Spirorbis arietina.

Dawson's description of *Spirorbis arietina.*

Spiral; sinistral; whorls four, the first three regularly spiral, and somewhat close, the last becoming irregular; cross section circular; shell thin, with delicate tubular structure, much finer than in *S. carbonarius;* surface uneven, with obscure wrinkles on the last whorl, and microscopic lines of growth on earlier whorls; apex flattened for attachment on first whorl only; length 1-10 to 1-8 inch (about 3 millimetres.)

of this limestone is about N. 23° W. <9°. The underlying conglomerate was not exposed; but there is no reasonable doubt of its occurrence beneath, and I have no evidence yet to show that the mass is here of less volume than farther to the west.

Place of concretionary limestones on the East River.

The calcareous band with which these concretionary limestones are associated was not observed above the conglomerates on the East River, but immediately north of the position where they terminate, on the east side of the stream, after a concealed interval of 200 paces, they are succeeded by whitish sandstones, dipping north at an angle of 16°, which, a little way on, is reduced to 8°, and this low rate of inclination is maintained by the measures for a considerable distance toward Pictou, with an occasional flat undulation, reversing the dip. The apparent place of the limestone would be in the concealed interval in question.

4. PRODUCTIVE COAL MEASURES.

Productive coal measures.

In the district which has engaged my special attention, the thick covering of drift so extensively concealing the strata, the dislocations which are known to affect these in some places, and the facts which suggest the probability of disturbances in others, while little has yet been revealed by crop workings, will make it difficult, for some time to come, to build up a column shewing a perfect series of the measures; and what is now offered is to be considered as only a distant approximation to the truth, to be improved hereafter as occasion may serve, and farther developments may occur.

McLellan's Brook section.

The most continuous exposure of the strata observed lies in the channel of McLellan's Brook, in which the rocks are bared, with short intervals of concealment, from nearly its mouth to the gap between McLellan's and McGregor's Mountains, and much farther beyond. But this section does not reach the highest strata, and some of the measures are repeated by an undulation. A portion of the beds, however, is seen nowhere else.

The highest coal seam with which I have been able to connect the section, appears to me to be one of which the crop was ascertained by Messrs. McBean, on the dividing line between the first and second square mile of their three-mile area, going south-eastward, and about 250 paces from the stake at the south-western end of the line. Here there are five

The specimens described were found by Mr. E. Hartley, in limestone belonging to the coal formation, and immediately overlying the New Glasgow conglomerate. The occurrence of *Spirorbis* in this bed is mentioned in *Acadian Geology*, p. 326, but it is not distinguished from the ordinary S. *carbonarius*, from which, however, Mr. Hartley's specimens shew it to be very distinct. It is so regularly spiral that it might be mistaken for a gasteropod shell; but its apex, flattened for attachment, and its microscopic structure, show it to be a worm shell. It was probably, like S. *carbonarius*, attached to submerged plants; but in the limestone above mentioned, it occurs loose in great numbers, having probably been drifted from its attachment. J. W. D.

Six-feet coal seam.

small trial-pits and bore-holes in a distance of about eleven chains on the strike. In one of these, according to Mr. A. McBean, seven feet of coal were pierced under five feet of gravel, and in another five feet of coal under three feet of gravel, while the crop was touched in the others. The average strike of the crop is about N. 67° E., and the dip southward, but I am not able to state the rate of slope.

A little to the west of north from this, at a distance of about twenty-two chains, reduced to a straight line, directly across the strata, Messrs. McBean sunk a trial-pit and bore-hole on the south side of St. Mary's road, not far from the house of Mr. J. McDonald (turner), penetrating, at the depth of twenty-feet, through four and a-half feet of coal. This they consider to be the same seam as that to which they sunk a pit about eighteen chains to the eastward of north from it, where it was four feet four inches in thickness, and identical with the seam which they worked by a slope about sixteen chains farther on the crop to the north-westward. This seam was previously worked by a slope about thirty-five chains still farther to the north-westward, by Mr. George McKay, for which reason it goes by the name of the George McKay four-feet seam. To the deep of McKay's slope, the Pictou Mining Company have sunk a shaft to this seam, at the Marsh Colliery, completed in October, 1868, and we thus have a section of part of the ground between McBean's six-feet and four-feet seams.

George McKay four-feet seam.

The inclination of the strata at McKay's slope is about 1 in 4, the dip at the mouth of the slope being N. 34° E., <16°; but the measures appear to spread considerably, going round by the crop to St. Mary's road, and it is probable that the rate of dip there is not more than 1 in 4½. This would give about 310 feet between McBean's six-feet and four-feet seams, and place the six-feet seam about ninety feet above the measures intersected in the Marsh pit. Combining these with what can be gathered from the Marsh Brook and McLellan's Brook, the following would be the series, as near as I can make it out from measurements by pacing, made by myself in 1868, and remeasurements by chain by Mr. Hartley in 1869.

Marsh pit.

Divisions and sections.

For the convenience of comparison this whole series of deposits is divided into three parts or horizons—A, B, and C, and Sections under these are given in sequent numbers.

Division A, including Section 1.
Division B, including Sections 2, 4, 5, 6, 8.
Division C, including Sections 3, 7, 9.

SECTION 1. (DIVISION A.)

MEASURES INTERSECTED IN THE MARSH COLLIERY PIT.

	Ft.	In.	Ft.	In.	Measures Marsh pit.
Dark gray argillaceous shale	3	0			
Gray impure fireclay	49	0			
			52	0	
Coal.—The Captain seam					
Gray fireclay			3	0	Captain seam.
Gray arenaceous shale	4	10			
Gray solid sandstone	3	0			
Gray argillaceous shale	4	6			
	8	9			
Coal.—A seam of inferior quality			21	1	
Gray fireclay			1	8	
Gray arenaceous shale	4	0			
	6	10			
Coal			10	10	
Gray fireclay			0	3	
Gray arenaceous shale	3	5			
Gray fireclay	7	10			
Gray strong solid sandstone	2	0			
Gray sandstone	24	4			
Gray arenaceous shale	18	6			
	8	4			
Coal.—The Mill-race seam.			64	5	
Cannel coal	0	9			Mill-race seam.
Mineral charcoal mixed with coal	0	3			
Good coal	2	1			
			3	1	
Gray soft fireclay, without divisions, holding occasional nodules of clay ironstone	17	6			
Gray flaggy sandstone, with thin black partings arranged in wavy layers	8	9			
Gray hard sandstone in one bed	6	0			
Gray shaly sandstone, with interstratified bands of gray hard sandstone of from one to four inches thick	19	6			
Dark gray argillaceous shale, with a few nodules of clay ironstone	11	9			
Coal—The George McKay seam.			63	6	
Coarse shaly coal	0	3			George McKay seam.
Good coal	3	6			
			3	9	
			223	7	

SECTION 2. (DIVISION B.)

MEASURES ON MARSH BROOK, FROM THE GEORGE MCKAY FOUR-FEET SEAM TO MCLELLAN'S BROOK.

	Ft.	In.	Ft.	In.	Measures Marsh Brook.
Gray fireclay, with great abundance of *Stigmaria*	3	0			
Measures not well ascertained, but supposed to consist chiefly of arenaceous shale and flaggy sandstone, with some black carbonaceous shale at the top	190	0			
			193	0	

		Ft.	In.	Ft.	In.
Ten-inch seam.	*Coal.—The ten-inch seam.* A trial-pit has been sunk on the crop on the Marsh Brook				
	Fireclay				10
	Black carbonaceous shale, chiefly	2	6		
		90	0		
				92	6
Oil shale.	*Oil shale.*—A seam worked to a small extent in a trial-pit on Marsh Brook, sunk by Mr. Halliburton; the thickness is uncertain.				
	Measures concealed			4	0
	Black carbonaceous shale	42	0		
	Measures concealed	5	0		
	Light gray arenaceo-argillaceous shale	69	6		
	Black argillaceous shale not well exposed, there being many small intervals of concealment	6	0		
	Measures concealed	72	0		
	Dark bluish-gray argillaceous shale, not well exposed	31	0		
	Measures concealed	20	0		
	Black carbonaceous shale	12	0		
	Measures concealed	16	9		
	Black carbonaceous shale	30	0		
	Measures concealed	10	0		
	Black argillaceous shale	14	9		
	Measures concealed	10	3		
	Black carbonaceous shale	26	8		
	Measures concealed	9	9		
		2	9		
				384	5
Small coal seam.	*Coal*, Cannel				3
	Gray fireclay	3	0		
	Light and dark gray fine grained flaggy sandstone	6	8		
	Yellowish-drab thick bedded sandstone, weathering rusty	8	0		
	Measures concealed	5	9		
	Yellowish-drab thick bedded rusty-weathering sandstone	4	8		
	Bluish-gray flaggy sandstone, with occasional carbonaceous partings	5	0		
	Measures concealed	38	0		
	Bluish-gray flaggy sandstone	1	0		
	Measures concealed	30	6		
	Yellowish-drab sandstone, in thin layers with false bedding, some parts weathering brownish-red	3	0		
	Measures concealed	4	5		
	Dark bluish-gray, brown-weathering sandstone, in some parts rust-brown	3	0		
	Dove-gray slightly arenaceous fireclay, weathering greenish-gray, and very soft when weathered	1	3		
				114	3
Supposed coal seam.	*Coal.*— A seam supposed probable here			0	0
	Measures concealed	7	5		
	Bluish-gray fireclay banded with dark gray, in layers from one-fiftieth to one-twentieth of an inch thick, the whole weathering dark brown or almost black	1	6		
	Measures concealed	13	0		
	Light bluish-gray argillaceous shale	0	6		
	Measures concealed	8	0		
				30	5
				619	8

SECTION 3. (DIVISION C.)

MEASURES ON MCLELLAN'S BROOK FROM THE MOUTH OF MARSH BROOK TO BLACK'S MILL-SITE.

	Ft.	In.	Ft.	In.	Measures McLellan's Brook.
Gray arenaceous shales and sandstones, some beds weathering purplish-brown or reddish	25	0			
Black carbonaceous shale	8	0			
Measures concealed	35	0			
Gray flaggy sandstone	3	8			
Measures concealed	79	0			
Very dark bluish-gray sandstone, extremely hard and fine grained and weathering brown	1	0			
Measures concealed, but there appears to be sandstone in the bed of the stream	32	0			
Black carbonaceous shale	28	0			
			211	8	
Coal.—A seam of hard coal but of fair quality			7		Small coalseam.
Very light gray fireclay, full of carbonized *Stigmaria*	2	3			
Gray argillaceo-arenaceous shales and flaggy sandstones, passing into each other	16	0			
Whitish-gray very compact heavy bedded freestone	3	4			
Light and dark gray argillaceous shales	4	6			
Black coaly carbonaceous shale	2	0			
			28	4	
Coal.—The Widow Chisholm seam,—of fair quality but hard			1	0	Widow Chisholm seam.
Yellowish-drab argillo-arenaceous very fine grained underclay with *Stigmaria*	2	3			
Dark gray compact sandstone, weathering rust-brown, full of *Stigmaria*	2	0			
Dark gray compact sandstone, weathering rust-brown, with occasional clay ironstone balls	3	7			
Dark yellowish-drab and brownish-drab sandstone, weathering rust-brown, in rather coarse thick beds	5	5			
Dark yellowish-drab and brownish-drab flaggy sandstones with very micaceous partings between some of the beds	25	0			
Measures concealed	14	6			
Dark yellowish-drab and brownish-drab flaggy sandstones shewing large casts of *Calamites cistii*, some of them four inches in width	2	0			
Measures concealed	2	3			
Dark yellowish-drab sandstones	9	6			
Dark yellowish-drab sandstones only partially exposed	49	0			
Dark yellowish-drab sandstones with false bedding and ripple-mark, and having black micaceous partings more conspicuous towards the base	61	0			
Black semi-carbonaceous shale, with occasional clay ironstone balls	20	0			
Black highly carbonaceous shale, compact, with two sets of cleavage planes, dividing it into cuboidal blocks about one foot in diameter	5	0			
Purplish-gray fine grained sandstone	6	6			
Measures concealed	9	9			
Black carbonaceous shale	3	9			

		Ft.	In.	Ft.	In.
	Measures concealed	15	0		
	Black carbonaceous compact shale	8	3		
	Measures concealed	8	6		
	Yellowish-drab heavy bedded sandstone, weathering light drab	11	4		
	Measures concealed	8	10		
	Yellowish-drab sandstone	9	6		
	Measures concealed	16	6		
	Yellowish-drab sandstone, generally flaggy, with wavy dark micaceous partings	34	6		
	Brown arenaceous shale, weathering gray	5	6		
	Gray argillaceous shale	1	6		
	Black carbonaceous shale, very compact	4	6		
	Light gray arenaceous shales and sandstones, with a few inches of gray argillaceous shale at the base, containing a band of clay ironstone two inches and a-half thick	15	9		
	Ash-gray sandstone, very heavily bedded, one of the beds thirty-three inches thick, without any partings	12	2		
	Grayish-drab coarse sandstones, with rust-stained partings	8	3		
	Measures concealed	24	6		
	Yellowish-drab sandstones, in thick beds, with wavy partings and much false bedding	10	0		
	Yellowish-drab flaggy sandstones	6	6		
	Gray rusty-weathering sandstone	0	8		
	Bluish-gray argillaceous shale	2	6		
	Yellowish-drab sandstone	49	6		
	Measures concealed	26	3		
	Yellowish-drab sandstone	2	0		
	Measures concealed	3	2		
	Yellowish-drab sandstone	9	0		
	Measures concealed	3	2		
	Black highly carbonaceous shale, very compact and not easily broken	29	0		
				547	10
Small coal seam.	*Coal*			0	3
	Yellowish-drab underclay, full of *Stigmaria*, and holding occasional disseminated clay ironstone balls from one-eighth to one-fourth of an inch in diameter	2	9		
	Measures concealed	2	0		
	Light gray compact rusty-weathering sandstone	0	6		
	Light gray arenaceous shale, weathering of a greenish tinge, in coarse beds with dark partings	1	6		
	Light gray fine grained arenaceous shale with dark partings	2	9		
	Light yellowish-drab sandstone	2	6		
	Measures concealed	17	6		
	Very light yellowish-drab sandstone, weathering red, with much false bedding	10	8		
	Measures concealed	3	6		
	Very light yellowish-drab sandstone with much false bedding	1	0		
Upright *Sigillaria*.	Gray sandstone, weathering drab. At the bottom of this there is a fragment of an upright *Sigillaria*; it is a sandstone core of about seven inches long, with a diameter of four inches and a-half; it is constricted towards the bottom, and then spreads out a little on a thin layer of shale beneath. No				

	Ft.	In.	Ft.	In.
roots were observed beneath, and the shale on which it is based passes just over the top of another upright *Sigillaria*, a few feet removed on one side	4	0		
Gray sandstone with three inches of shale on top	1	0		
Gray sandstone, weathering drab; the lower and upper parts of the bed are somewhat shaly, with two inches of soft clay on top	2	3		
Dark gray argillaceous shale, with nodules of clay ironstone. In this bed, in the distance of twenty-five feet, there are the remains of three upright *Sigillariæ*. The largest of them is about eighteen inches in diameter; a length of forty-three inches of it remains. Towards the lower part it becomes constricted and then spreads out to a wider diameter on the bed beneath. It is a sandstone cast of the plant. The remains of the other two occur at the top of the bed, in the form of sandstone cores, each of them about seven inches long, one of them being five inches and the other seven inches in diameter; the former penetrates eleven inches into the layer of sandstone above, and the hollow semi-cylindrical mould of the other is visible in the upper bed for forty-five inches, from which the plant has been removed, while at the length of twenty-four inches in the sandstone the form is cut by two inches of soft shale. All the three plants probably had roots in the same bed of shale beneath, and these may have penetrated to a bed of sandstone still lower, which is marked by the presence of *Stigmaria*, but no connection could be found between these roots and the upright plants	4	0		
Gray argillaceous shale	1	0		
Gray soft argillaceous shale or clay	0	3		
Gray flaggy sandstones in irregular layers, with remains of prostrate plants	1	6		
Gray sandstone in a single bed, marked by the presence of *Stigmaria*	3	0		
Gray flaggy sandstones, weathering drab, with wavy surfaces, interstratified with argillaceous and arenaceous shales	7	0		
Gray arenaceous shale and thin sandstones interstratified with beds of dark gray argillaceous shale	4	0		
Gray arenaceous shale, with beds of sandstone weathering to a mottled red and drab	6	0		
Measures concealed, probably flaggy sandstones	28	0		
Gray flaggy sandstone, weathering drab, with ripple-mark	16	0		
Gray argillaceous shale, with layers of gray flaggy sandstone, which are wavy and weather to a mottled drab and red	5	0		
Gray flaggy sandstone interstratified with gray arenaceous shale.	7	0		
			134	8
			924	4

Three upright *Sigillariæ*.

This section terminates near the old mill-site belonging to Messrs. S. Black and A. Walker, where the measures appear to be interrupted by a fault. Evidences of a disturbance are plainly visible in the cliff overlooking the stream on the right bank; but I was unable to make out

Black's mill-site.

clearly, from the cliff, which way the measures are thrown. In McLellan's Brook, all the way up to the mouth of Marsh Brook, the strata of Division C

S. E. dip. dip to the south-eastward. On the main stream, above the junction of the tributary, the same dip is maintained in the prolongation of the Marsh Brook series (Division B) to within twenty-six chains of the Fulling-mill bridge, the slope of the strata, all the way from Black's mill-site, varying from 8° to 20°. The measures are largely composed of sandstones, the strike of

Black shales McLellan's Brook. which is, of course, south-westward. From Black's mill-site downwards to the junction of McLellan's Brook with the East River, the measures are apparently all black shales, the chief part of them carbonaceous, giving a great thickness, with no sandstones observed. The dip of these shales is

N. E. dip. more or less north-eastward, at angles ranging from 8° to 24°. Their strike would be south-eastward, and in the prolongation of the strata in this direction, they would apparently come against the sandstones irregularly. The continuous contact of these two masses is concealed, but a line running about S.S.E. from Black's mill-site, crossing the old mill road a little north of the house of Mr. J. W. Turnbull, and coming on McLellan's Brook in the gap between McLellan's and McGregor's Mountains, would apparently have the sandstones on the east, while the black shales would be on the

Mill-road fault. west, and it is probable that a dislocation, which may be called the Mill-road fault, more or less coincides with this line all the way. As no mass of arenaceous measures presenting the same characteristics as those of McLellan's Brook, is known below the black shales, the sandstones are supposed to be the higher in the series, and the dislocation would thus seem to be a downthrow to the eastward; but what may be the extent of the break, the evidence is not at present sufficient to decide.

As already stated, the south-eastward dip of the arenaceous measures on McLellan's Brook is maintained to within twenty-six chains of the

Oil shale. Fulling-mill bridge. At this point, a seam of oil shale, formerly worked

Patrick's working. by Mr. Patrick, comes upon the brook. It is supposed to be on the same horizon as the oil shale on Marsh Brook, and the strata associated with it being more exposed on the main stream than on the tributary, we obtain additional details.

Synclinal. The measures here lie in the form of a synclinal, on the opposite sides of which, at the right margin of the stream, the two out-crops of the oil

Fault. shale are about 200 paces apart. A fault runs in the brook in a bearing of N. 36° W. It appears to be a downthrow on the north-west side, producing on that side a greater separation of the out-crops. On the northern out-crop the evidences of the dislocation are in the middle of the stream, where black shales, on the south-east, come against sandstones on the north-west. Between the two there runs a thin vein of quartz, the underlie of which is N. 54° E. $<$ 38°, and fragments of the quartz obtained from the vein, shewed well marked slickensides next the sandstone.

On the south out-crop, and on the north-west side of the fault, there are the remains of an old slope sunk by Mr. Patrick. The dip at the mouth of the slope is N. 22° E. <29°; and I was informed by Mr. A. McBean that in descending this slope the oil shale maintained a thickness of from two to six inches for about twenty feet; it then gradually thickened to five feet in descending sixty feet farther, while the dip gradually became N. 67° E. <52°; descending eight feet more, the deposit diminished to nothing; and in eight feet still further, the face of the fault presented itself, the strata becoming vertical. In the thickest part of the oil shale, a horizontal gallery was driven twenty yards to the left, and in this distance the seam thinned from five feet to fifteen inches, then again thickened and again thinned.

Patrick's slope on oil shale.

Variation of thickness.

From the description of Mr. McBean, and from the specimens shown me, the best and most typical parts of the oil shale appear to have a curly or felt-like structure. It is this part which varies so much in thickness, and while the bottom of the deposit remains even, the thinning arises from depressions in the upper portion, which are filled up with even layers of the more ordinary carbonaceous shale. The out-crops approach one another to the north-west, and the turn on the axis of the synclinal occurs about 300 yards from the margin of the brook. The measures associated with the oil shale on the opposite out-crops, as exposed on the brook, are as follows, in descending order, both sections belonging, of course, to the Division B:

Felt-like structure of oil shale.

Axis of synclinal.

SECTION 4. (DIVISION B.)

MEASURES ON THE SOUTH OUT-CROP FROM THE HIGHEST BEDS SEEN ABOVE THE OIL SHALE UP MCLELLAN'S BROOK TO THE FULLING-MILL BRIDGE.

Measures on south out-crop.

	Ft.	In.	Ft.	In.	
Brownish-gray fine grained sandstone, weathering brown	0	9			
Measures concealed	4	7			
Gray compact sandstone, with wavy micaceous partings	0	10			
Measures concealed	2	0			
Dark gray flaggy sandstone, weathering brownish-gray	1	0			
Measures concealed	5	3			
Bluish-gray argillaceous shale	2	3			
Measures concealed	2	0			
Bluish-gray argillaceous shale	1	6			
Black highly carbonaceous shale	13	6			
Measures concealed	13	8			
			47	4	
Oil shale.—A seam varying in thickness from one inch to eight feet			4	0	Oil shale.
Measures concealed	26	0			
Black argillaceous shale	8	10			
Black carbonaceous shale	3	5			
Measures concealed	164	0			
			202	3	

		Ft.	In.	Ft.	In.
Coal seam.	*Coal.*—A seam on which a pit has been sunk about 125 paces on the strike (S. 64° E.) from the margin of the brook.				
	Cannel coal	0	3		
	Bituminous coal	1	6		
				1	9
	Grayish-drab fine grained arenaceous underclay with *Stigmaria*.	3	0		
	Gray sandstone with wavy partings, and holding occasional clay-ironstone balls	2	4		
	Measures concealed	7	4		
	Dark gray arenaceous fireclay	7	0		
	Measures concealed	8	0		
	Light gray rusty-weathering sandstone, in thick beds	0	0		
	Measures concealed	2	3		
	Light gray soft-weathering arenaceous fireclay	1	8		
	Gray rusty-weathering sandstone	1	3		
	Measures concealed	2	0		
	Black semi-carbonaceous fireclay, slightly arenaceous, with a whitish-brown streak	5	0		
	Measures concealed	12	6		
				58	4
Coal seam reported.	*Coal.*—A seam reported to be here			1	0
	Very dark gray fine grained fireclay, weathering very soft, with *Stigmaria*	1	10		
	Light gray arenaceous underclay, with dark partings, holding *Stigmaria* and casts of *Calamites cistii*	1	6		
	Light gray sandstone, with occasional clay ironstone balls	4	3		
	Dark gray shaly sandstone	2	0		
	Dark gray sandstone in thick beds	12	0		
	Measures concealed, with one or two small exposures of dark semi-carbonaceous indurated shale	43	0		
	Dark gray, rusty-weathering sandstone, not well exposed	24	0		
	Measures concealed	9	0		
	Dark gray rusty-weathering sandstone				
	Measures concealed, but probably sandstone of the same character	25	0		
				122	7
				437	3

SECTION 5. (DIVISION B.)

Measures on north out-crop.

MEASURES ON THE NORTH OUT-CROP FROM THE HIGHEST STRATA SEEN ABOVE THE OIL SHALE, DOWN MCLELLAN'S BROOK.

	Ft.	In.	Ft.	In.
Brownish-gray fine grained sandstone in one bed, weathering brown	1	3		
Measures concealed	0	6		
Light gray compact sandstone	2	6		
Measures concealed	0	6		
Light gray flaggy sandstone	5	0		
Dark bluish-gray argillaceous shale	1	6		
Dark brownish-gray sandstone	4	6		
Measures concealed	22	0		
Black semi-carbonaceous shale	15	0		
			52	9

	Ft.	In.	Ft.	In.	
Oil shale.—A seam of black highly carbonaceous shale, containing lenticular masses of a substance like oil shale, as proved in a pit sunk to by the Pictou Mining Company			0	4	Oil shale.
Black carbonaceous shale	2	0			
Measures concealed	15	4			
Light bluish-gray argillaceous shale	1	6			
Black carbonaceous shale	9	0			
Measures concealed	46	0			
Black carbonaceous shale	5	0			
Measures concealed	17	6			
Black semi-carbonaceous shale	5	0			
Black argillaceous shale	6	8			
Black carbonaceous shale	5	0			
Black carbonaceous shale, very compact and tough	5	3			
Measures concealed	13	6			
Brownish-drab thick bedded sandstone, weathering rusty, with black micaceous partings	4	5			
Gray very fine grained sandstone, with clay ironstone balls	4	9			
Gray very fine grained sandstone, partially concealed	6	6			
Very light gray fine grained sandstone, weathering rusty in the partings	1	4			
Gray sandstone, with black partings	27	6			
Brownish-drab flaggy sandstone, weathering brown	3	9			
Blackish-gray argillo-arenaceous shale, interstratified with light-gray arenaceous shale, with black partings	6	6			
Dark brownish-drab fine grained sandstone, weathering rusty	4	9			
Dark bluish-gray arenaceous fireclay, weathering very soft in some beds	6	11			
			198	2	
Coal.—A seam supposed probable in this place			0	0	Supposed coal seam.
Dark bluish-gray arenaceous fireclay, partially concealed	7	5			
Measures concealed	20	0			
Gray sandstone, with black wavy micaceous partings	24	10			
Measures concealed	7	8			
			60	0	
Coal.—A seam supposed to be about this horizon			0	0	Supposed coal seam.
Measures concealed	80	0			
Black carbonaceous shale	9	7			
			89	7	
			400	10	

Both of these sections terminate at dislocations. That concluding at the Fulling-mill bridge comes against a break of considerable importance; its course appears to be N. 77° E., and it may be called the Fulling-mill fault. Fulling-mill fault.

The whole area of Productive coal measures belonging to that part of the Pictou field which has been under the examination of Mr. Hartley and myself, is included between two great upthrow dislocations, which may be termed the North and South faults. The former crosses the East River a little above New Glasgow bridge, where it brings the productive measures abruptly against the New Glasgow conglomerates. It thence runs to Great North fault.

Sutherland's River along the south side of the triangular area of Millstone Grit rocks which has been previously described, the bearing being about S. 82° E. for one-half of the distance, and S. 68° E. for the other. The South fault crosses the East River about three and a-half miles further up, skirts the north side of McGregor's Mountain, and intersecting McLellan's Brook about seventeen chains above the Fulling-mill bridge, passes along the north foot of McLellan's Mountain and strikes Sutherland's River about fifty chains below McPherson's bridge. This fault has on the south side the Devonian rocks of McGregor's and McLellan's Mountains, bringing those of the former mountain to abut against the great mass of black shales* lying west of the Mill-road fault, and those of McLellan's Mountain against the higher and more arenaceous deposits of the divisions A, B, and C.

Great South fault.

Black shales.

Arenaceous measures.

Immediately east of the Mill-road fault these more arenaceous deposits appear to occupy the whole space between the North and South faults, in which space they are arranged in three synclinal forms, the axes of two of which, bearing eastward, are a little more than a mile and a-half apart; one of them, already alluded to, running in the vicinity of Patrick's old workings on the oil shale, and the other a little north of the pit sunk at the Marsh colliery to the George McKay four-feet coal seam. There is however a third parallel synclinal axis, over half a mile north of the latter, which passes along the upper part of Potter's Brook near the telegraph road, and comes obliquely against the North fault. These synclinals may be called the South, Middle (or Marsh), and North, the Middle one being the most important.

Three synclinals.

South, Middle and North.

George McKay coal seam.

The out-crop of the George McKay seam on the south rise of the Middle synclinal is seen in the George McKay slope, and its course from this, as marked by the Pictou Mining Company's trial-pit, (thirty-six feet to the coal), and McBean's slope on the crop, is about S. 62° E. But farther on, as already indicated, it takes a more southward course, and folding over the axis of the anticlinal, which lies between the Middle and South synclinals mentioned, it reaches the St. Mary's road about 200 paces south-eastward of the house of Mr. Jas. McDonald, (turner), in McBean's trial-pit and bore-hole. It has not been tested by continuous trial-pits farther on, but between fifty and sixty chains to the south-west, in what appears to be the general strike of the measures, a trial-slope, about 230 paces outside of Messrs. McBean's south-western boundary, has been sunk on a coal seam on the left bank of a small stream running north-westward near the house of Mr. McGregor.

McBean's trial-pit.

Trial-slope near McGregor's.

According to Mr. A. McBean, the thickness of this seam is three feet six

* It is supposed to be possible that a triangular area of Millstone Grit rocks may be interposed for part of the way between the South fault and one branching from it, and that towards the East River the black shales may abut against such rocks.

inches, and the dip at the mouth of the slope, which is about four feet above the stream, is S.16°E.<19; but at nine feet down the slope the roof suddenly assumed an inclination of 70°. In another slope sunk at the level of the brook and a few paces to the north-east, the sudden increase of inclination occurred at a depth of about four feet; and by this it would appear that a fault is here present running about east and west, which would account for the irregularity of the strike at the mouths of the slopes. This seam is supposed to represent the George McKay four-feet seam. The dislocation may be called the McGregor fault.

McGregor fault.

On the right bank of the same brook, about a quarter of a mile further up, and a little within the south-western boundary of the McBean area, three small trial-pits have been sunk on a coal seam about four hundred paces from the south-west corner of the line between the first and second square miles. The thickness and character of the coal, I am not able to state with exactness, but the former appears to be from three to four feet, and the coal is covered by at least eight feet of black shale. The dip at the crop is S. 43° E. $< 17\frac{1}{2}°$; but according to Mr. McBean the inclination, after descending a short distance, suddenly increases to a considerable angle, and a crack in the coal at the bend is filled with shale similar to that of the roof. If the dip of the measures to the north-west be the same as that at the crop, this seam would appear to be about 160 feet over the George McKay seam, which is about the horizon of the Captain seam in the Marsh pit.

Coal seam supposed equivalent to the Captain seam

Several trial-pits and slopes have been sunk upon the south out-crop of the Captain and Mill-race seams in the vicinity of the Marsh pit, establishing the run of these seams, and shewing apparently a small divergence from the George McKay seam, going eastward, probably from some diminution of the inclination. Proceeding in an opposite direction from the George McKay slope, trial-pits which have been sunk on the crop of this seam, as pointed out to me by Mr. Lawther, exhibit the turn of the seam upon the axis of the synclinal about thirty chains westward from the Marsh pit, and the run of the Marsh pit group of seams on the north rise is indicated first by a slope sunk by Mr. Lawson on the Captain seam, for the Merigomish Company, near the north-west boundary of their area, about twenty-two chains from the south-west corner post.

Captain and Mill-race seams.

Axis of Middle synclinal.

The coal is here three feet thick, and the dip at the mouth of the slope is S. 20° E. $< 17\frac{1}{2}°$. This inclination continues for eighty feet down the slope, when a downthrow occurs about equal to the thickness of the coal, beyond which the inclination becomes 22°, and continues so for forty feet. In a bearing N. 67° E. from this, at a distance of about 850 paces, Mr. Lawson, by direction of Mr. Moore, has tested the whole of the Marsh pit group of seams, on a small stream which flows down the south slope of the

Captain seam, Merigomish area.

Marsh pit group tested by Lawson.

McPherson's Brook.

hill from Donald McPherson's land. Here Messrs. McBean had sunk a small slope on the Captain seam, at a spot about six chains from the north-west and about twenty-four chains from the north-east boundary lines of their area.

According to Mr. A. McBean the thickness of the seam is here four feet, and the average dip of the measures is S. 28° E. < 45°. Agreeably to the measurements of Mr. Lawson, reduced to vertical thickness at right angles to the plane of the beds, the following is a descending section of the seams, with their distances apart:

			Ft.	In.
Captain seam.	*Coal.—The Captain seam*			
	Intermediate measures		4	0
	Coal		21	0
	Intermediate measures		0	10
Mill-race seam.	*Coal.—The Mill-race seam.*		85	10
	Good coal, half of it being cannel	0 6		
	Clay	0 8		
	Good coal	1 0		
	Shaly coal	1 10		
	Intermediate measures		4	0
George McKay seam.	*Coal.—The George McKay seam.*		52	2
	Shaly coal	0 10		
	Good coal	3 6		
	Shaly coal	0 3		
	Good coal	0 3		
			4	10
			172	8

Increase of thickness.

The same measures in the Marsh pit gave 171 feet 7 inches, by which it appears that though there is some difference in the intermediate thicknesses, the total difference is only thirteen inches, while three of the coal seams have increased in volume.

Coal seam above the Captain seam.

A little over 200 paces down McPherson's Brook, from the slope on the Captain seam, another coal bed occurs, said to be about ten inches thick. It is exposed on the right bank of the brook, and is about 400 feet directly across the measures, from the out-crop of the Captain seam. Taking its inclination to be about 30°, which would be about the average of the angles in the trial-slopes on each side, its vertical distance over the Captain seam would be about 200 feet. On the Marsh Brook above the mill-pond, and about 600 paces from the north-west boundary of the McBean area, two trial-pits, about two chains apart, have been sunk by Messrs. McBean on the land of Mr. Jas. McDonald (Grayer). Mr. A. McBean describes the seam to be composed as follows:

	Ft.	In.	
Cannel coal	0	4	Four-feet seam above Captain seam.
Mineral charcoal mixed with coal	1	0	
Good brilliant coal	0	8	
Coal bored through	1	9	
	3	9	

The level course between the two pits is very nearly north, with a slope to the west, said to be about 1 in 6, or 9°, the low angle and irregular bearing of the dip no doubt arising from the circumstance that we are here approaching to the axis of the synclinal curve. The southern of the two pits is about 300 paces from the assumed south crop of the Captain seam; but having no means of determining the law of the curve it is not possible to calculate the vertical distance of the one seam from the other, nor to state what may be the relation of the higher one to the coal bed in the lowest position on McPherson's Brook. Axis of synclinal.

Beyond McPherson's Brook the Captain seam appears to run along a dingle supplying a tributary streamlet, a quarter of a mile up which there is a red ferruginous spring,* which is supposed to give evidence of its presence at the foot of a steep rise on a farm road leading up into D. McPherson's fields on the top of the hill. Should this seam and those associated with it continue in the same course for half a mile farther, they would come against the great North upthrow fault, the effect of which, however, may possibly turn them a little south of west and continue their out-crop somewhat farther eastward; but of this there is as yet no evidence. Red spring. Contact of seams with North fault.

Somewhat over a mile south-west from the red spring, on the tributary of McPherson's Brook, and about thirty-three chains from the south-east boundary of their area, Messrs. McBean have sunk a trial-pit through eleven feet of drift and one foot of greenish-gray arenaceous shale, to a coal seam, of which the following is a section: McBean's six-feet seam.

	Ft.	In.
Cannel coal	0	1½
Good coal	0	4
Coarse coal and black carbonaceous fireclay	1	0
Good coal of rather coarse texture	2	6
Coal not so good, with hard shaly bands	2	6
	6	5½

The crop of the seam rises in a small brook (the upper part of the Marsh Brook) about twenty feet to the south-westward, with a strike N. 37° E.; but a trial-pit sunk by Mr. Lawson on the crop about 160 paces north-eastward of the previous one, would appear to show the strike Lawson's trial pit.

* The proximity of coal seams to the surface is so often indicated by red ferruginous springs, that these springs, called by Welsh miners *the blood of the coal*, are sometimes taken as a guide in the search for out-crops.

between them to be N. 47° E. Another trial-pit, sunk by Messrs. McBean, about 210 paces still farther on the strike and some distance across the measures to the south-eastward, shews a seam, the strike of which, as represented by Mr. J. McBean, appears to be again N. 37° E. Constructing the distribution of the seams from these elements, the vertical distance between them would appear to be about fifty-seven feet. The seam is said to be composed of six feet of good coal.

Another six-feet seam.

Conjectured equivalence of seams.

These two seams, being on the south rise of the Middle synclinal, are conjectured to represent the Mill-race and the George McKay seams, which they resemble in character, though both are much thicker. But the inferences to be deduced from this equivalence are of so much importance, as will be seen by the sequel, that it ought not to be taken for granted until the presence here of the whole group of the Marsh pit seams has been proved by trial-pits in a straight line at right angles across the measures; which probably would not be a very expensive operation, seeing that the drift in the vicinity is by no means very deep.

Trial-pits required to prove Marsh pit group.

McBean eight-feet seam.

At about 1450 feet across the measures, behind the lower of these seams, there occurs a bed of excellent coal of eight feet and a-half thick, on which Messrs. McBean have sunk a slope about five chains from the south-eastern and twenty-nine and a-half chains from the north-eastern boundaries of their area. The dip at the mouth of the slope is N. 55° W. < 33°, and as far as observed the measures seem to preserve this inclination all the way to the six-feet seam above. This would give a vertical distance between them, at right angles to the planes of stratification, of about 800 feet, and the following is a rude approximation to a descending section of the ground as far as we have been able to ascertain the facts:

SECTION 6. (DIVISION B).

Measures above McBean's eight-feet seam.

MEASURES BETWEEN MCBEAN'S SIX AND EIGHT FEET SEAMS.

	Ft.	In.	Ft.
Coal.—A seam conjectured to be equivalent to the *George McKay seam*			6
Black carbonaceous shale	40		
Upper conglomerate. Greenish-gray conglomerate with silicious pebbles, varying in size from a quarter of an inch to two inches in diameter. This is not seen on the line of section, but at some distance to the eastward, and its true place may possibly be somewhat lower among the concealed measures	80		
Measures concealed	200		
Greenish-gray fine shaly sandstone	30		
Black carbonaceous shale only partially exposed	40		
			390
Seam of poor coal. *Coal*—Coaly shale	2	8	
Good coal	0	4	
			3

	Ft.	In.	Ft.	
Light yellowish fireclay with *Stigmaria*	20	0		
Measures concealed	28	0		
Dark brownish-gray argillaceous shale, with six inches of black compact carbonaceous shale at the bottom, holding many well preserved scales of *Diplodus*, half an inch in diameter	4	0		*Diplodus* scales.
			52	
Coal—Good coal	0	10		
Coaly shale	0	2		
			1	Coal seam small
Dark gray underclay with *Stigmaria*, and bluish-gray fireclay	4	0		
Measures concealed	60	0		
Drab-gray fine grained sandstone partially exposed	20	0		
Measures concealed	30	0		
Greenish conglomerate with quartz pebbles, associated with fine grained sandstone, only partially exposed	30	0		Lower conglomerate.
Measures concealed	45	0		
Black shale, a band of which at the top is carbonaceous and is said to burn with a bright flame like oil shale	54	0		
			243	
Coal.—A seam reported by Mr. A. McBean to be probably here but of uncertain thickness			1	Reported coal seam.
Measures concealed	95	0		
Bluish-gray arenaceous shale	15	0		
			110	
Coal.—*The McBean eight-feet seam*			8	McBean eight-feet seam.
			814	

Behind the McBean eight-feet seam Mr. Lawson has sunk several trial-pits on the McBean area, and Mr. Robert Mitchell has sunk a number of others on the Mitchell and Barton area which adjoins it on the south-east. By these pits the measures have been partially tested to a horizontal distance of about fifteen chains, in which the inclination of the strata gradually increases from 33° up to 55°, while they remain very parallel to one another on the strike, and a descending section of the ground, at right angles to the plane of the beds, is as follows, as nearly as has been ascertained :

Lawson and Mitchell's trial-pits.

Steepening of measures.

SECTION 7. (DIVISION C.)

MEASURES BENEATH MCBEAN'S EIGHT-FEET SEAM.

	Ft.	In.	Ft.	In.	
Greenish-drab underclay with *Stigmaria*	3	0			
Measures concealed	6	0			
Yellowish-drab shaly sandstone	14	0			
Black and dark gray argillaceous shale	14	0			
			37	0	
Coal.—A seam of an inferior shaly character			3	0	Seam of poor coal.
Gray underclay	2	0			
Measures concealed	8	7			
Yellowish-drab shaly sandstone	4	6			
Black argillaceous shale	4	6			
			19	7	

		Ft.	In.	Ft.	In.
Small coal seam.	*Coal.*—Coal of inferior character				
	Good coal	0	2		
		0	1		
	Brownish-drab fireclay, with *Stigmaria*			0	3
	Measures concealed	2	3		
		7	0		
Small coal seam.	*Coal.*—A seam of inferior quality			9	3
	Gray fireclay			0	2
	Brownish-drab compact sandstone	3	9		
		4	6		
Seam of very good coal.	*Coal.*—A seam said to be of remarkably good quality			8	3
	Gray compact fireclay			2	6
	Gray compact argillaceous shale, with some beds of fine arenaceous shale	5	0		
	Measures concealed	10	0		
	Gray argillaceous shale	50	0		
		4	0		
Olden's seam.	*Coal.*—This is called *Olden's seam.* It appears to be a black shining flaky argillaceous shale. It is not seen on the line of section but somewhat to the eastward, and this would be its place provided no fault intervenes			69	0
	Gray fireclay			0	2
	Measures concealed	1	0		
	Greenish sandstone, weathering drab	68	0		
	Measures concealed	12	0		
	Gray sandstone, weathering to a brilliant orange or rusty reddish-yellow from peroxyd of iron	37	0		
		16	0		
Small coal seam.	*Coal.*—Shaly coal			134	0
	Good finely laminated coal	0	2		
		0	1		
	Light and blackish-gray sandstone, interstratified in alternating bands of about one-fourth and three-fourths of an inch thick			0	3
	Light yellowish-drab rusty-weathering sandstones	40	0		
	Yellowish-gray and brownish-gray fine grained sandstone, weathering to an Indian-red	14	0		
	Yellowish-drab and dark gray red-weathering fireclay, crumbling into small fragments	18	0		
	Measures for the most part concealed, but two trial-pits show yellowish-drab brown-weathering or rusty-weathering sandstone, in wavy layers	32	0		
	Yellowish-drab arenaceous fireclay, weathering Indian-red	247	0		
	Measures concealed	6	0		
	Brownish-gray arenaceous shale, with dark brown bands in layers of from one to two inches	80	0		
	Black arenaceous very compact shale, with brownish-gray streaks	8	0		
		3	0		
				448	0
				731	5

Crop of eight-feet seam to E.

Mr. J. Weir has traced the out-crop of the McBean eight-feet seam for about eighteen chains in a bearing N. 45° E. from McBean's slope to the south-east boundary of the McBean area. Here it bends a little more to the eastward, and it partially crosses the corner of the Mitchell and

Barton area where it seems to be interrupted by a fault, but the seam may possibly be found ultimately to be the same as that struck in Haliburton's pit on the St. Lawrence area, somewhat less than half a mile beyond, where it apparently comes against the great North fault. In the other direction from McBean's slope Mr. Lawson has sunk a series of trial-pits on the crop, tracing it in a bearing S. 37° W. for thirty-five chains, whence it gradually bends to S. 22° W. for between five and six chains farther. By this it appears that the crop runs unbroken for very nearly three-quarters of a mile on the McBean area. At the south-western end of this, however, it meets with a serious interruption in the occurrence of a great dislocation. This appears to produce an upthrow on the south side, but what the extent of the break may be has not yet been quite determined. The position of this break having been ascertained by Mr. Lawson, it is proposed to designate it by his name. In bearing it appears to be about S. 77° W., and in this direction it may have a connection with the Fulling-mill and the McGregor faults.

Crop of eight-feet seam to W.

Lawson fault.

If the measures are not interrupted by other disturbances, the Lawson fault would permit a much farther extension westward to the out-crop of the overlying six-feet than to that of the eight-feet seam, and by a series of trial-pits along the out-crop of the six-feet seam for the purpose of proving this, the increased workable extension of the eight-feet seam beneath would be proved at the same time.

If by a proper transverse examination in the vicinity of the six-feet seam this should be found equivalent to the George McKay four-feet, or any one of the Marsh pit group, it would of course be immediately inferred that the eight-feet seam will occur some 700 or 800 feet beneath the bottom of the Marsh pit, and its out-crop might thus be sought for near the mouth of the Marsh Brook.

Position of eight-feet seam on Marsh Brook

Although there are too many intervals of concealment on the lower part of the Marsh Brook, as well as between the six-feet on the upper part of the brook and the eight-feet seams, to permit an accurate comparison of details, yet it will be perceived by a reference to Section 2 (Division B), that at the depth of 789 feet beneath the George McKay seam there occur some bands of fireclay, and although no coal was seen associated with them, this would apparently be a favorable position in which a search for the eight-feet seam might be instituted. This spot is on the Pictou Mining Company's area, and the occurrence of the eight-feet seam here would establish its existence not only over the whole north-western part of the McBean area and carry it some distance on that of the company just named, but place it also under a considerable portion of the George McKay and other areas in the neighbourhood.

In the 730 feet of arenaceous measures which have been partially examined beneath the McBean eight-feet seam, Section 7 (Division C), there occur in the lower half many bands of sandstone which weather to various tints of red, giving them externally the aspect of beds belonging to the Millstone Grit, and without careful examination they might be mistaken for such. There are beds on McLellan's Brook, in the lower part of Section 3 (Division C), which have the same peculiarity, though by no means to the same extent, the effect of the weathering being to give the surface of the rock merely a mottled red and green colour. An instance of this is very conspicuous in a flagstone quarry on the top of a narrow ridge formed by a sharp turn on the right bank of McLellan's Brook, a little above Black's mill-site; and it serves to assimilate the strata of the two localities.

Red-weathering sandstones.

Allusion has heretofore been made (p. 16) to five small trial-pits and bore-holes on the crop of a coal seam sunk by Messrs. McBean on the line between their first and second square miles (going south-eastward) about 250 paces from its south-western extremity. The dip is here southward; but at the extremity of the line it appears to be northward. There is thus a synclinal form in the interval; and through this interval is supposed to run the Lawson fault, throwing the measures up on the south side. In the vicinity of the stake at the extremity of the line there are obscure evidences of the occurrence of a series of greenish-grey conglomerates with silicious pebbles. These conglomerates are better seen near the residence of Mr. Alexander McLean junior, where, as I was informed, the rock was met with in excavating the cellar of the building; and it occurs in two very small ravines between 200 and 300 paces westward. Similar conglomerates in a lower stratigraphical place are well displayed near the residence of Mr. Alexander McLean senior, at the foot of McLellan's Mountain, where the rock is intersected by a mountain brook to the east of the house. On this brook, Mr. Haliburton has tested two coal seams; one above the lower conglomerates, by a trial-pit on what is said to be a four-feet seam, at the foot of the hill, and another a short distance on the rise of the hill, where a four-feet seam immediately under the conglomerates and their associated sandstones, is naturally exposed.

Synclinal form.

Greenish conglomerates.

Four-feet seam.

The dip of the conglomerates at the more northern position is about N. 43° W. < 13°; approaching the more southern conglomerates, it is about the same in direction, with an inclination of 19°, and at the out-crop, up the hill, the inclination increases to about 24°. Constructed from these elements as a guide, the following would appear to be a descending section of the ground, to which, of course, the amount of concealment must give some uncertainty:

SECTION 8. (DIVISION B.)

MEASURES INTERSECTED ON THE LAND OF MR. A. McLEAN, SEN.

	Ft.	Ft.	Measures on A. McLean's land.
Greenish-grey conglomerates with silicious pebbles of various sizes up to two inches in diameter, many of them consisting of white quartz..	85		Conglomerates.
Measures concealed.....	22		
		107	
Coal.—A seam of which the *wash* is seen about fourteen chains to the westward of the line of section.....		0	
Greenish-grey sandstone with much false bedding, seen about nine chains to the eastward	20		
Measures concealed.....	290		
		310	
Coal.—A seam sunk to by Mr. Haliburton, near McLean's barn, said to be		4	Four-feet coal seam.
Measures concealed.....	25		
Greenish-grey conglomerate with silicious pebbles of various sizes up to two inches in diameter. This is not seen on the brook but to the westward of McLean's house.....	37		
		62	
Coal.—A seam is supposed to be probable here		0	Supposed coal seam.
Grey arenaceous underclay with *Stigmaria*.....	3		
Greyish-drab flaggy sandstone	12		
Black carbonaceous shale	13		
Greenish-drab coarse conglomerates with silicious pebbles of various sizes up to two inches and a-half in diameter, in an arenaceous cement .	30		Conglomerates.
Yellowish-drab and greyish-drab flaggy sandstones with partings shewing carbonized plants	18		
Black carbonaceous shale.....	3		
Greenish-drab flaggy sandstone.....	16		
Greenish-drab coarse conglomerate, as before.....	8		
Yellowish-drab flaggy sandstones and coarse conglomerates, partially concealed	55		
Dark greyish-drab moderately thick bedded sandstone with many impressions of plants.....	5		
		163	
Coal.—A seam opened by Mr. Haliburton at the crop. This may be called *The Mountain seam*		4	Mountain seam.
		650	

By comparing Sections 6 and 8, it will be seen that there are two series of conglomerates in each, with no great difference of distance apart, while there is nothing in the one section seriously contradicting the other, so far as known. Immediately beneath the lower conglomerates in Section 6, the measures are concealed, and these coarse beds may extend farther down; but the change in the sediments to carbonaceous shales a little lower would make the base of the conglomerates appear to be a position in which a coal seam might reasonably be expected. The discovery of such there would cause the parallelism of the two sections to be more complete, and render a search for the McBean eight-feet seam at the distance indicated between it and the conglomerates in Section 6, a reasonable undertaking in the

Supposed place of the McBean seam.

vicinity of the Mountain seam. The vertical distance would appear to be from 150 to 200 feet. At an angle of 25° the horizontal distance would be between 350 and 500 feet. But within this distance behind the Mountain seam at McLean's, the whole of the productive coal measures are probably disturbed or perhaps cut off by the great South upthrow fault, very nearly to a contact with which, the Mountain seam can be traced westward. It would therefore be necessary to follow the Mountain seam some distance to the eastward to get the space required, and the most convenient place would be in the vicinity of the St. Mary's road, about half a mile from McLean's, where the measures do not appear to be greatly covered up with drift.

Contact of Mountain seam and South fault.

Should the coal seams which are above the summit of Section 6 prove, on proper examination, to be the Marsh-pit group, it would follow that the upper conglomerates beneath them would represent the sandstones which underlie the George McKay seam at the Marsh Colliery, and to these would also be equivalent the conglomerates at the summit of Section 8, by which it would appear that the break in the Lawson fault would exceed the distance between the George McKay seam and the one next above the Captain seam, or be over 370 feet.

Equivalence of conglomerates.

Break in the Lawson fault.

Where the McBean eight-feet seam is interrupted by the Lawson fault, it abuts against strata associated with a series of coal seams which have been tested on McLean's Brook, where this brook runs through the land of Mrs. McLean, a widow lady; they are in consequence known as the Widow McLean seams. The coal which has been obtained from them is of inferior quality, and the seams are not known to have been met with anywhere else. There is little doubt that they underlie the McBean eight-feet, but at what vertical distance there appears as yet no clue to determine. They have been traced from the McBean area to that of Mitchell and Barton, where the highest of them crops out on the south side of St. Mary's road, about forty paces south-eastward from McBean's corner-post.

Widow McLean seams.

In their explorations, Messrs. Mitchell and Barton have not yet been able to find these seams beneath the McBean eight-feet on the east part of their area, nor the eight-feet above them on the west part. The vertical distance to which they have tested the ground by trial-pits in the former case is approximately given in Section 7 (Division C), where it appears to be about 730 feet, while that to which their researches have extended above and below the Widow McLean seams in the latter, as collected from the correlation of their numerous trial-pits, and of natural exposures, is presented in the following descending section:

SECTION 9. (DIVISION C.)

MEASURES INTERSECTED ON AND NEAR McLEAN'S BROOK.

	Feet.	In.	Feet.	In.	Measures McLean's Brook.
Light-grey very hard and tough underclay with *Stigmaria*...	2	0			
Measures concealed	57	0			
Grey sandstone banded with dark brown streaks; the rock weathers rust-brown and holds *Stigmaria*.....	6	0			
Measures concealed.....	3	0			
Dark brown arenaceous shales, with carbonized impressions of *Cordaites borassifolia*.....	4	0			
Measures concealed.....	16	0			
Black argillaceous shale	5	0			
Measures concealed	35	0			
Grey arenaceous shales with ferruginous bands prevailing most towards the bottom, and weathering rust-yellow, while the rest of the beds weather a deep brown.....	6	0			
Dark grey arenaceous shale, with *Stigmaria* and *Cordaites borassifolia*	2	6			
Measures concealed.....	16	0			
Yellowish-drab fireclay, full of indeterminate *Calamites* casts, replaced by clay iron-stone	6	0			
Measures concealed.....	3	0			
Yellowish-drab fireclay, full of indeterminate *Calamites* casts, replaced by clay iron-stone	3	0			
Measures concealed	12	0			
Greenish-drab coarse grained sandstone, stained reddish-brown in the partings, which are full of carbonized comminuted plant-casts	4	0			
Measures concealed.....	20	0			
Light grey sandstone with argillaceous partinge carrying indeterminate plants.....	5	0			
Measures concealed.....	32	0			
Black carbonaceous shale full of bivalve shells resembling *Modiola*.....	2	0			
			239	6	
Coal or coaly shale.....				3½	Small coal seam.
Measures concealed.....	10	0			
Dark brown arenaceous shales, the colour passing into black.	3	0			
Measures concealed.....	7	0			
Grey underclay with *Stigmaria*	4	0			
Measures concealed.....	120	0			
Light grey flaggy sandstone with black carbonaceous partings, holding *Noeggerathia*, casts of *Calamites* and other indeterminate plants.....	4	0			
Measures concealed	30	0			
			178	0	
Coal.—The Widow McLean ten-feet seam (so called.)					Widow McLean ten-feet seam.
Bad shaly coal	6	8			
Good coal	1	6			
			8	2	
Dark grey argillo-arenaceous underclay with *Stigmaria*	1	6			
Measures concealed.....	36	0			

		Ft.	In.	Ft.	In.
	Light grey arenaceous shale	2	0		
	Brownish-grey argillaceous and very ferruginous shale, approaching to a clay ironstone; the exterior weathers off in curved scales, as if from some concretionary structure, and the shale contains small indeterminate plant casts, resembling *Cordaites*	1	6		
	Blackish-brown arenaceous shale with black plant-casts; this is followed by blackish arenaceous shale with black carbonaceous partings, containing specks of mineral charcoal and presenting large forms of *Stigmaria* and impressions of *Sigillaria*, too imperfect for specific determination	1	0		
				42	0
Widow McLean thirteen feet seam.	*Coal.—The Widow McLean thirteen-feet seam* (so called.)				
	Coaly shale, in which occur interstratified laminæ of coal of from a twentieth to a quarter of an inch thick, with impressions of large forms of *Stigmaria*, with the stigmata or rootlet scars as large as a quarter of an inch in diameter	1	0		
	Good coal, much laminated	1	10		
	Dark fireclay	0	4		
	Coal with many bands of finely laminated shaly coal; it breaks in cleavage joints at right angles to the plane of bedding and shows laminæ of from a twentieth to a hundredth of an inch thick, with a very brilliant lustre. The planes of deposition are slickensided, as if from great pressure, and then lateral movement, such as would result from corrugation	9	0		
				12	2
	Light bluish-grey fireclay, full of black carbonized *Stigmaria*	1	0		
	Measures concealed	5	5		
				6	5
Widow McLean third seam.	*Coal.—The Widow McLean third seam*, said to be inferior coal.				
	Measures concealed			2	9
Widow McLean fourth seam.	*Coal.—The Widow McLean fourth seam*, said to be inferior coal			15	0
	Measures concealed			2	9
	Yellowish-drab fireclay, having very distinct carbonized impressions of *Cordaites borassifolia*	254	0		
		6	0		
				260	0
	Coal.—Black argillaceous shale and fireclay mixed with coaly matter	3	3		
	Coal of a fair quality		9		
				4	0
	Bluish-grey fireclay with *Stigmaria*	1	0		
	Measures concealed	39	0		
	Brownish very compact sandstone	0	8		
	Very dark brown arenaceous shale, weathering blackish-brown.	0	8		
	Greyish-drab arenaceous shale or sandstone, resembling a fireclay, yielding readily to the weather and exfoliating in curved scales from the surface, as if from a concretionary structure	4	0		

	Ft.	In.	Ft.	In.
Greenish-drab conglomerate with a reddish tinge, perhaps from weathering; it holds pebbles of various sizes up to two inches in diameter, many of them of white and grey quartz and some of red sandstone	3	0		
Measures concealed	90	0		
Dark grey hard sandstone in even layers varying in thickness from one quarter to three quarters of an inch; they would be well suited for the purposes of tile-stones	30	0		
Greenish-drab conglomerate with silicious pebbles	1	8		
			170	0
			941	0

While the general strike of the strata associated with the Mountain four-feet seam appears to be about S. 40° W., that of the Widow McLean group is S. 8° W., and this divergence makes it seem probable that the difficulty of the search for the McBean eight-feet seam between the two will be enhanced by a dislocation, the position and amount of which have yet to be discovered. Probable fault.

The above section occupies a breadth of about 630 paces, in which the westward slope of the strata gradually increases from 30° at the summit to 58° at the base, and at a farther horizontal distance of about 280 feet across the measures to the eastward, in which the strata are concealed, there occurs an exposure of red conglomerate, more resembling beds belonging to the New Glasgow conglomerate or to the Mill-stone Grit than any seen interstratified with the workable coal seams. This mass, of which I could not determine the dip or strike, occurs on McLean's Brook, about 200 paces, following up the stream in a north-westerly bearing, from the pond of Mr. Finlay McDonald's saw-mill. From the head of the pond down to the mill there is a distance of about 200 paces in a direction nearly east, the strata in which are probably of the same character as the red mass farther up, and at the mill-dam coarse brick-red or Indian-red shales become exposed on the right bank of the brook, some of the beds of which display a few disseminated silicious pebbles of a couple of inches in diameter. Red conglomerate. Red shales.

In the bed of the stream under the mill a band of limestone makes its appearance. It is obscured by the refuse slabs ejected from the mill, but up in the cliff on the left bank it is again exposed, and here it has been quarried to a small extent. The limestone is brownish-grey in colour, and holds obscure fossils, some of which are probably *Spirorbis carbonarius*. This band of limestone, which is limited on each side by coarse red shales, is eighteen feet thick, and some small portions of it seem to be made up of hard masses of limestone surrounded by greenish shale. The dip of the bed is N. 87° E. < 55°. Fossiliferous limestone.

About one hundred and twenty paces eastward another calcareous band runs up the cliff. It is about sixteen feet thick, and may be a

repetition of the previous one, either through an undulation or a dislocation, the dip being S. 72° W. < 86°. The strike in each case would be nearly north and south, but that of the strata farther down the brook appears, with many irregularities, to run more with the trend of the valley, which is nearly east. Somewhat under a mile down the valley, and about three hundred paces north of the brook, there is still another exhibition of limestone near the house of Mr. Finlay McDonald (sawyer.) Here the band is eleven feet thick, in very regular layers, which are interstratified with thin partings of shale. A copious spring issues from it, and the band can be traced for one hundred and twenty paces to the westward of the spring, with a general dip of N. 30° W. < 75°; while it is again met with in a bearing of N. 80° E., at a distance of about 250 paces from the same spot.

McDonald's limestone.

Millstone Grit rocks.

The rocks in the valley to the southward, judged of by two exposures on the north and one on the south side of McLean's Brook, are red shales, red sandstones, and red conglomerates, associated with greenish-drab sandstones and shales. Strata of a similar description are occasionally exposed in the valley all the way to Sutherland's River, and the whole bear a strong resemblance to the deposits of the Millstone Grit.

Strike of limestones.

The strike of the limestone, near McDonald's house, points towards the exposures near his saw-mill, and notwithstanding the irregularities which the latter display, the whole may belong to one and the same band. Supposing this to be the case, it is very evident that the trend of the strata associated with the limestones diverges considerably from that of the measures accompanying the Widow McLean and the McBean coal seams.

Absence of black shales at the surface.

At right angles to the McBean seam, there is between it and McDonald's house, a distance of three-quarters of a mile, and in this there has yet been discovered no evidence of the emergence of the great mass of black shales, which it has been previously stated abuts against the Mill-road fault, notwithstanding that the Lawson fault is a considerable upthrow to the south in the interval. It cannot be supposed that the Mill-road fault suddenly annihilates these black shales, and this disturbance being a downthrow to the eastward, the inference is that the shales underlie the arenaceous coal measures to the east of it; and as the strata associated with McDonald's limestones probably belong to the Millstone Grit series, it follows that they must be brought to the surface by some very great fault running at an uncertain distance north of McDonald's house. The course of this fault has yet to be ascertained; but one point on it probably occurs at the exposure of red conglomerate above McDonald's mill-pond.

Probable fault.

It will be seen by the sequel that the thickness of the black shales can scarcely be much less than about 2000 feet. According to Mr. Hartley, the workable coal seams which have been tested on the west side of

the East River, are interstratified in an additional thickness of measures, equal to about 500 feet, and below these he states the occurrence of a series of arenaceous and argillaceous beds, without any very valuable coal seams, but still belonging to the productive measures, of which the volume may be 1000 feet more. It thus appears possible that without allowing anything for the New Glasgow conglomerates the great break which brings the Millstone Grit rocks to the surface at the east end of the coal field, may be an upthrow of at least 3500 feet; it will probably run across from the South to the North fault and it may appropriately be termed the great East fault. Great break. East fault.

The relation of the Widow McLean seams to the McBean eight-feet seam not having been as yet ascertained with accuracy, it is a question how far they may be beneath the bottom of the Marsh pit in the Middle synclinal. But as their outcrop has not presented itself on McLellan's Brook, it seems probable that they are sufficiently deep seated to abut, in their south rise, against the black shales in the Mill-road fault. The Widow McLean seams can therefore scarcely be expected to come to the surface in any other place than south-east of the McBean eight-feet seam; but it would appear from a comparison of Sections 2 and 3 with Sections 6 and 7, that Messrs. Mitchell and Barton have as yet scarcely carried their researches far enough behind that coal seam to reach them. Horizon of the Widow McLean seams.

It has been conjectured that the Widow McLean seams may be the eastern out-crop, in a deteriorated condition, of some of those workable seams which underlie the great mass of black shales. If such were the case, it would follow that the fault between them and the Mountain seam would be a much greater break than has been supposed by me, and the block of strata with which these seams are associated would apparently be a quadrangular mass limited by four great breaks, namely, the one just alluded to, the Lawson fault, the great East fault and the South fault. But until the search for the McBean seam behind the Mountain seam, and for the Widow McLean seams behind the McBean seam, has been exhaustive, it will be premature to speak with anything but doubt of the structure of this part of the coalfield.

On the St. Lawrence area, black shales appear to have been obtained in nearly a dozen trial-pits, embraced in a space of about one hundred acres, lying southward of Haliburton's main shaft. The shales are characterised by the presence of an abundance of *Cythere*, with many small scales and minute bones of fishes, but it does not appear probable that the shales will have any very great thickness. Their position seems to be on a continuation of the axis of the Middle synclinal, and the measures may be expected to preserve on the whole a moderate inclination. Indeed Mr. J. Weir, formerly employed as pitman by Mr. Haliburton, pointed out to me a trial- St. Lawrence area. Black shales. Middle synclinal.

Flat measures.

pit about one hundred and eighty paces from the main shaft in a bearing S. 20° W., where he informed me the measures were quite flat. It is true that Mr. Brain, formerly Mr. Haliburton's overman, states in his manuscript journal, with a copy of which Mr. Haliburton was so kind as to furnish me, that the measures in this same pit dip S. 20° E. (Mag.) < 30°; but in a pit about seventy paces southward he registers the dip as N. 20° E. (Mag.) < 30°. In the interval the measures will naturally become flat, so that there is no great discrepancy in the structure as given by the two.

St. Lawrence coal seam.

The St. Lawrence main shaft is eighty feet deep, and according to Mr. Brain's register the coal was penetrated at a depth of forty-five feet. It was there but three feet nine inches thick, but ten feet above the bottom of the shaft it had thickened to eight feet horizontally, while at fifty-six feet further down on the slope of the seam it became eleven feet, one-half being good coal and the other coaly shale. At the depth of the shaft a gallery or level was cut in the coal twenty-two feet to the westward and eighteen feet to the eastward. A transverse drift was carried back from the shaft at a depth of seventy-five feet, and a bore-hole then driven at right angles to the slope of the measures, which dipped towards the pit at an angle of 75°; in these, according to Mr. Weir, there were intersected the following strata:

In the drift and shaft.

Red shale.

	Ft.	In.	Ft.	In.
White fireclay	9	0		
Red shale	7	6		
White fireclay	12	0		
			28	6

In theBore-hole.

White hard fireclay	12	0		
White soft fireclay	1	6		
Red shale	7	6		
White hard freestone	31	0		
			52	0
			80	6

These details are given because they seem to indicate, by the tilted attitude of the measures and the colours of the strata, which are characteristic of the Millstone Grit series, that the face of the great North fault or of some immediate branch of it, must, at the depth of eighty feet from the surface, be close behind the bottom of the shaft.

North fault.

As previously stated, the out-crop of the McBean eight-feet seam on leaving the south-eastern boundary of the McBean area, and entering upon the Mitchell and Barton area, gradually bends round and assuming more of easting than shewn in its previous course, is supposed to be interrupted by a fault. The precise course of this disturbance has not yet been ascertained, nor is it definitely know whether it is an upthrow or a downthrow.

Fault breaking McBean's eight-feet seam to E.

If it were the latter, its effect would naturally be to steepen the dip of the coal seam where in contact with it, and this dip, whatever its rate, would probably be northward. We see in the St. Lawrence pit that the effect of the North fault has been to produce a slope of the measures in an opposite direction, and it does not appear to me an improbable conjecture that the coal seam penetrated in that pit may possibly be the return of the eight-feet seam to the surface on the north side of a trough which lies between the two dislocations. It is possible also that the seam may abut against both these faults, and perhaps against the supposed great East fault, and thus shew no out-crop around the east end of the area which it may occupy, until it emerges near the St. Lawrence pit. After emerging, the out-crop gradually separates a little from the North fault in the neighbourhood of that pit; but as the fault gradually gains upon higher measures as it proceeds westward, the out-crop of the coal seam will again probably approach the fault and once more become concealed by it. Possible equivalence of the St. Lawrence seam.

If the fault which interrupts the McBean eight-feet seam were an upthrow, the coal bed in the St. Lawrence pit could scarcely represent it, and further facts would have to be ascertained before the true structure could be given. It may be remarked, however, that the eastward strike of McBean's six-feet seam on the upper part of Marsh Brook, which is conjectured to be equivalent to the George McKay seam, appears to run such a course, that it will probably come against a mass of conglomerate which occurs south-eastward from Mr. William Grant's house in that neighbourhood. This conglomerate is supposed to be the same as that which underlies the coal seam in question, as stated in Section 6. The dip of the measures is there northwestward, and the presence of the conglomerate in such a relation would, in reality, indicate an upthrow on the east side of a disturbance. If the course which this disturbance may present, should point to the eastward interruption of the McBean eight-feet seam, the upthrow of this seam might be considered as established. Upthrow fault.

About twelve chains from the north-east corner of the McBean area in a bearing N. 55° E. there is an exposure of greenish-gray conglomerate, dipping N. 43° W. < 40.° Were the fault an upthrow, this exposure would seem to represent the lower conglomerate of Section 6, and the crop of the McBean eight-feet seam would probably have the same relation to it on the east side of the disturbance, that McBean's slope has to the conglomerate on the west. Conglomerate.

The Mill-road fault, as has been stated, runs about S.S.E. from Black's mill-site on McLellan's Brook, and its course can be pretty well seen in the line of demarcation which it presents between the arenaceous measures on the east and the black shales on the west. But what its precise course may be, northward, or what effect it may produce upon the distribu- Mill-road fault.

Arenaceous measures.

tion of the measures in that direction, I have found no satisfactory evidence to determine. Arenaceous measures extend westward beyond the direct northern prolongation of the bearing given to the fault; but with a very little deflection westward the chief mass of sandstones would still keep on the east side, where they rise into a considerable hill, along the south-western foot of which the St. Mary's road runs to New Glasgow. The eastward prolongation of this hill appears to constitute the north-west limit of the Middle synclinal. The hill is supposed to have an anticlinal form, and rising on it to the north-eastward from Black's mill-site, we have some evidence of north-western dips on the land of Mr. Andrew Campbell. Near his house on the top of the hill is a well sunk through three feet of soil and thirteen feet of arenaceous shale and shaly sandstone; the dip, as explained to me by Mr. Campbell, was found to be N. 17° E. < 10°.

Anticlinal form.

N. W. dips.

Farther north-eastward the rocks are so covered with drift that I have not been so fortunate as to meet with exposures shewing slopes in the same direction, but evidences of a synclinal, whose axis would run on the other side of the hill until cut off obliquely by the great North fault, are met with under three-quarters of a mile north-eastward, where several coal beds have been worked to a small extent on Potter's Brook. The ground, however, is here so broken by faults running in various directions, while the amounts of displacement are not known, and so affected by minor undulations, that it is next to impossible to correlate the seams with one another with any degree of certainty.

North synclinal.

A. McKay's five-feet seam.

One of these seams occurs on the south side of the brook, where it was formerly worked by Mr. Alex. McKay, who informed me that the coal was of excellent quality, and who gave me the following section of the ground immediately beneath:

		Ft.	In.
	Coal—A seam of excellent quality	5	0
Calcareous underclay.	Ash-gray calcareous underclay, characterized by a great abundance of well-preserved forms of *Stigmaria*	1	6
	Ash-gray fireclay, becoming mottled with red by exposure to the weather, and holding *Stigmaria*	7	0
	Coal—A seam of which the thickness was not ascertained	0	6
		14	0

The strike of the out-crop, as determined by the work on it, is about N. 62° W., with a slope to the north-eastward, but I am uncertain of the angle of inclination.

Fraser's five-feet seam.

About 300 paces N. 20° E. from this, on the north side of the brook, a horizontal gallery was opened many years ago (the colliery was visited by me when it was in work in 1841) by the late Mr. Alex. Fraser, in a seam of excellent coal from four and a-half to five feet thick. The mouth of the

gallery is about fifteen feet over the brook and immediately under the south side of the telegraph road. The gallery in its general course is about N. 82° W., and it extends about 120 paces under ground, with a sudden turn southward about thirty paces in. The dip is northward, but as the natural out-crop on the face of the bank presents an arch, first rising southward towards the road and then falling again beyond to the level of the brook farther down, it is evident that the horizontal gallery would turn at some uncertain distance beyond the extent to which it has been carried, and come out again to the crop in the bank at the same height of fifteen feet above the brook, shewing by this a fold over the axis of an anticlinal form or roll in the strata. On the south side of the brook, nearly opposite to this point, a slope sinks southward in what is supposed to be the same seam, and a rise in this on the south side of a synclinal might be expected to bring the seam into junction with that worked by Mr. Alex. McKay; but a fault appears to run between the two positions on or near the axis of the synclinal and renders the identification less certain. According to Mr. Poole, however, a calcareous underclay of twenty-two inches supports the Fraser coal, and further assimilates the two seams.

Small anticlinal form.

Fault.

Calcareous underclay

Immediately east of the mouth of Fraser's gallery a fault occurs, and vertical strata met with by Mr. George McKay, in a pit sunk about 135 paces southward, shew the bearing of the fault to be about S. 16° E. About 140 paces eastward of this fault, and on the south side of Potter's Brook, Mr. Lawson has sunk a slope for the Pictou Mining Company in a coal seam of which the following is a section:—

Fraser's fault

Lawson's coal seam.

	Ft.	In.
Cannel coal, varying in thickness from three to nine inches	0	6
Mineral charcoal mixed with coal	0	2
Good bituminous coal, of which from four to six inches at the bottom appears to be of a friable character	3	0
	3	8

The bearing of the slope is S. 26° E., with an inclination of 20° for twenty feet; of 35° for eighty feet; of 20° for thirty-five feet, with a sudden diminution to 16° at the bottom, where a disturbance occurs running N. 52° W. This disturbance cannot, however, be a great one, as it produces little displacement at the out-crop of the seam; but at some distance farther to the deep of the seam (supposed to be about seventy paces from the mouth of the slope) a much more important dislocation probably occurs. Its position is inferred from the presence of about thirty feet of vertical sandstone about nine chains to the eastward of the slope, and a coal seam two and a-half feet thick, in a vertical attitude, about fifteen chains beyond; the

Small fault.

A larger fault.

* Transactions of the Nova Scotian Institute of Natural Science for 1863, p. 38.

bearing these would give to the fault is about S. 72° W. What displacement this fault produces has not been ascertained, but a subordinate one appears to run parallel with it about eighty-five paces north of it, the bearing of which would bring it about twenty or thirty paces behind the mouth of Lawson's slope. Entangled with these disturbances there appear to be two ten-inch seams of coal and several very small ones, in addition to the one of two and a-half feet just mentioned, the whole of which are supposed to be beneath the seam of Lawson's slope, and with it to lie in a narrow synclinal form north of the more important of the parallel faults.

Still another fault.

Ten-inch coal seams.

Although the unknown amount of displacement produced by the fault at the mouth of Fraser's gallery prevents the stratigraphical relation of Fraser's and Lawson's seams from being accurately established, yet the character of the fuel in them has induced a comparison of the former with the George McKay seam and of the latter with the Mill-race seam. At any rate, it is but reasonable to suppose that these seams, with the rest of the Marsh-pit group, after cropping out on the north rise of the Middle synclinal, would, with the remainder of the measures, turn over to a northward dip and be found somewhere in connection with the synclinal of this part of Potter's Brook.

Comparison of coal seams.

About thirty chains from the telegraph road, on the old straight road leading to the Scotch church in New Glasgow, a pit has been sunk on the East River area, close by its northern boundary. According to information given me, it penetrates fourteen feet of drift, then fourteen feet of rock, the character of which I could not ascertain, and finally intersects a coal seam eight feet thick. At the bottom of the pit a slope was sunk for fourteen feet in the coal, at an angle of 60° in a bearing about south, to a face of sandstone cutting off the coal. The bearing of this dislocation I was not so fortunate as to learn; but a fault, of which Mr. Hartley has detected the presence on the west side of the East River, will run a little south of this, if it be not the same one. If Lawson's and Fraser's seams may be compared with the Mill-race and the George McKay seams, this one may be compared with the McBean eight-feet seam.

East river pit.

Eight-feet coal seam.

Fault.

Comparison with McBean's eight-feet seam.

The steepness of the seam here is no doubt due to the proximity of the great North fault, which passes about 120 paces behind it; but, after proceeding in this attitude for some distance westward, the strike of the measures appears to turn more south, while their slope diminishes. At a distance of about 700 paces from the pit, along the road near which it is situated, there is a descent in the surface, which runs about S. 30° W., and constitutes the north flank of a small but well marked ridge, which crosses the St. Mary's and telegraph roads just at their junction, and termi-

North fault.

nates near the establishment of the Crown Coal, Brick and Pottery Company. The higher part of the ridge is composed of a brownish-drab sandstone of considerable thickness. This probably underlies the East River eight-feet seam, but at what vertical distance is uncertain. Sandstone ridge.

At the Pottery works a pit was sunk to a three-feet seam of remarkably good coal by Mr. Jos. Richardson, and is hence called the Richardson seam, the measures intersected in the pit being as follows, with a dip of S. 57° E., < 19½°. The Richardson three-feet seam.

	Ft.	In.
Drift	16	0
Grey argillaceous sandstone, gradually crumbling in the weather	24	0
Coal—The Richardson seam, of remarkable good quality	3	0
Grayish-drab fireclay, with abundance of *Stigmaria*	3	0
Light yellowish-drab fireclay	11	0
	57	0

These measures would underlie the mass of sandstone forming the ridge, and the out-crop of the coal seam would follow the foot of the rising ground up to the great North fault; where it crosses the road to the Scotch church there is a red ferruginous spring to mark its probable position; but in its south-westward course, the seam will probably be interrupted by a dislocation of which there is evidence at no great distance beyond the Pottery. The excellent quality of this coal gives it a resemblance to that of a bed two and a half feet thick, which, as will be seen by Section 7, is about eighty feet beneath McBean's eight-feet seam. Comparison of seams.

At Chisholm's mill-pond, on Potter's Brook, about thirty chains southward of the Pottery pit, an excellent seam of coal, said to be well suited for blacksmiths' purposes, and reported to have a thickness of three feet, was formerly worked by the Rev. Mr. Stewart, and is hence called the Stewart seam. The measures associated with it, as near as I could ascertain, are as follows, in descending order:

	Ft.	In.	Ft.	In.	
Black carbonaceous shale			10	0	
Coal.—The Stewart seam			3	0	Stewart's seam.
Gray underclay	3	0			
Measures concealed, but probably black carbonaceous or argillaceous shale	120	0			
Gray sandstone, weathering drab	5	0			
			128	0	
Coal and black argillaceous shale			0	1	Small coal seam.
Gray soft fireclay	1	6			
Gray hard fireclay with indications of *Stigmaria*	3	6			
Grayish-drab standstone	2	0			
Gray argillo-arenaceous shale	1	0			
Grayish-drab sandstone	4	0			

		Ft.	In.	Ft.	In.
	Gray arenaceous shale	0	6		
	Blackish argillaceous shale	0	6		
	Gray flaggy sandstone	36	0		
	Black carbonaceous and argillaceous shale, only partially seen	50	0		
				99	0
Small coal seam.	*Coal.*—Cannel			0	11
	Gray fireclay	3	0		
	Black carbonaceous shale, only partially seen	105	0		
	Grayish-drab sandstone	25	0		
				133	0
				374	0

The sandstone at the base of the preceding section is seen on the west side of the New Glasgow road, at the bridge over Potter's Brook; and proceeding down the brook from this, the cliff on the right bank gives a continuous descending section, in which nothing is met with but black shales. These have been carefully examined by Mr. Hartley, and the direct breadth of them in the bearing N. 80° W. which is at right angles to the strike, is computed to be very nearly 475 paces, with angles of inclination varying from 33° to 47°. This would give a thickness of about 700 feet, and if to this be added 500 feet for what may be concealed to the middle of the river, the distance being fifteen chains and the supposed inclination 30°, the thickness would not be less than 1200 feet.

Black shales.

Chisholm's mill-pond.

The strike of the Stewart coal seam across Chisholm's mill-pond and in the two or three crop-pits on the north side of it, is about N. 18° W., with an inclination to the eastward of about 30°; but a search for the seam in this direction, by trial-pits approaching the Pottery, has proved unsuccessful. In a cliff on the right bank of the East River, above the railway bridge, there is a considerable exposure of strata, which very probably underlie the seam at a considerable depth. About a quarter of a mile above the bridge, black shales, which are a part of the strata exposed, dip N. 40° E. < 23°—25°, and this dip is preserved on the strike for 300 paces; but approaching within 200 paces of the lower end of the bridge, the strata suddenly becoming arenaceous, plunge with a dip of N. 5° W. < 43°—45°, maintained for 150 paces measured directly across the strike, while close by the extremity of the bridge there appears to be a dislocation. This displacement, which may be called the Bridge fault, would seem to run a little south of the Pottery pit on the Richardson seam, and the sudden bend in the measures would carry the Stewart seam considerably out of its course to the westward, and thus, aided by the break, which is probably a downthrow on the north side, would bring it much nearer the river.

Arenaceous strata.

Bridge fault.

Southward from Chisholm's pond the measures appear gradually to assume a more westerly bearing, the strike becoming S. 20° W., and at

the distance of between 300 and 400 paces from the pond they are interrupted by another dislocation. The evidences of this were observed by Mr. Hartley on the right and left banks of Potter's Brook, about a quarter of a mile below the New Glasgow road, where the dip of the black shales becomes S. 5° E. < 60°. The course of this fault seems to be about west; it is a downthrow on the south side, supposed to be of about 200 feet, and on this side of it the black shales turn south-eastward and gradually conform with the arrangement which they present on McLellan's Brook.

The great mass of black shales which immediately succeeds the band of sandstone on the west side of the New Glasgow road at Potter's Brook seems to indicate that we have here the base of the arenaceous measures and the summit of the black shales, and the position and arrangement of the mass render it probable that it is to be considered an addition to the thickness which Mr. Hartley has found to exist at the highest horizon in them on the west side of the East River, less the 200 feet repeated in the Potter's-brook fault. Their volume over the Main coal seam (more particularly described in Mr. Hartley's Report,) is, according to him, 1128 feet. If to this we add the 1000 feet occurring on and near Potter's Brook, we have a thickness of 2128 feet.

Summit of black shales.

Thickness of black shales.

It has already been stated that McLellan's Brook, below Black's mill-site, presents a great body of these black shales, and on the East River, above the mouth of this brook, there are farther exposures, reaching to the out-crop of the Main seam, where a slope has been opened on it by the Pictou Mining Company. The whole will give to the series a transverse breadth of a little more than a mile and a quarter, with a north-eastward dip varying in inclination from 8° to 24°. Such a computation as can be made from these elements would assign to the black shales on the west side of the Mill-road fault, at Black's mill-site, a volume of 1740 feet. As this is 388 feet less than the total thickness stated above, it would follow that the displacement produced by the Mill-road fault would equal this, with as much in addition as the base of the arenaceous measures may be underneath the surface on the east side of the fault at that spot. As already stated, the precise course of this fault northward from Black's mill-site remains a matter of uncertainty; and whether it is deflected so far as to run for the black shales at Potter's Brook and come to the East River near the railway bridge must continue a subject for future investigation.

Break in Mill-road fault.

Bearing of Mill-road fault.

The out-crop of the Main seam, upon which the coal works of the General Mining Association are situated on the west side of the East River, crosses the New Glasgow road about a quarter of a mile above the turn to the Albion mines, and the slope of the Pictou Mining Company, which for the present is abandoned, is seen about 120 paces east of the road. As a detailed description of this seam, as observed by Mr. Hartley on the

Main seam.

Reference to Mr. Hartley's Report.

west side of the river, was necessarily to be a part of his Report, it was left to him to follow the investigation of it and the seams and ground associated with it to the eastward. I shall therefore refer to him for what is to be said of it and of a shaft sunk to it on Grant's farm, further to the eastward. The strike of the seam from the Albion mines to the slope is about S. 70° E. (or S. 47° E. Mag.), the dip at the mouth of the slope being N. 20° E. (or N. 43° E. Mag.) $< 19\frac{1}{2}°$; but here the out-crop turns a little more southward, and a trial-pit has been sunk on it a quarter of a mile farther, in the bearing S. 45° E., thirteen chains beyond which it will come upon a fault, the course of which, as ascertained by Mr. Hartley on the west side of the river, is almost exactly east. About thirteen chains on the course of this fault a coal seam occurs on the south side of it, on the land of Mr. Donald McLeod. The following is a section of the seam, as given to me by Mr. Lawther, who sunk the trial-pit:—

Strike of Main seam.

McLeod seam.

	Ft.	In.
Coarse coal	2	6
Coaly shale in very thin layers	3	0
Good coal, or the best part of the seam	2	6
	8	0

The crop has been traced a distance of about 190 paces, and the dip of the strata is about N. 76° E. $< 19°$, black shale being above the coal seam, and sandstone supporting the underclay beneath. If this were the Main seam the displacement of the fault would be an upthrow of 286 feet on the south side; but the character of the seam is more like some of those lower down, and the upthrow, therefore, is probably much greater.

South fault.

This is the only coal seam I could hear of that has been struck on the south side of the fault above mentioned. Between the trial-pit on the coal, however, and the great South upthrow, which appears to pass a little south of the house of Mr. Neil McKay, there is a space of a mile in breadth. The strata striking south would run across this nearly at right angles to the direction of the South fault. If the coal seams reach so far it is probable that they may be deflected somewhat to the west on approaching the upthrow; but as already stated, it is not impossible that a southern portion of the space may be occupied by rocks of the Millstone Grit series, brought into place by a fault subordinate to the great one. I have no facts, however, on the east side of the East River, to shew how much this may be.

About 200 paces less than a mile from the run of the coal seam on Donald McLeod's land, and at right angles to the strike, a pit has been sunk for water on the land of Mr. William McLeod. The pit is sixty-three feet deep; no water was obtained, and judging by the *débris* lying about the mouth of the pit, it penetrates nothing but black shale. A lump of asphaltum is said to have been obtained at the depth of twenty-five feet,

Black shales.

but I presume it may have been oil shale, or highly carbonaceous shale. The position of the excavation is on the road which crosses McGregor's Mountain, and it is about 800 paces north of the South fault.

About 1400 paces still farther east, but, as is supposed, on the east side of the Mill-road fault, there is an old gallery or level on a seam of coal said to be three feet thick, over which rises a considerable thickness of black shale. The mouth of the level is seen at a great bend of McLellan's Brook, about 240 paces above the Fulling-mill bridge, and a little over 300 paces north of the South fault. The dip of the strata appears to N. 54° E. $<18°$. Three-feet coal seam, above Fulling-mill.

About 300 paces farther up the bend of McLellan's Brook, but not more than 300 paces on the road which runs southward from the Fulling-mill bridge, there is an exposure on the right bank of the brook, which would be on the east side of the Mill-road fault, and on the south side of the Fulling-mill fault, but it is uncertain to what division it may belong. The base of it reaches to within fifty paces of the Devonian rocks brought up by the great South fault. The following is a section of the strata in descending order:— Section of measures near Devonian rocks.

	Ft.	In.	
Greenish-drab arenaceous shale interstratified with layers of greenish-gray sandstone	22	0	
Black argillaceous shale with thin layers of sandstone	2	6	
Greenish-drab sandstone	0	6	
Black argillaceous shale	15	0	
Gray shaly sandstone	5	0	
Greenish-gray conglomerate with siliceous pebbles of various sizes up to an inch in diameter, in an arenaceous matrix	1	6	Conglomerates
Black shale	1	0	
Greenish-gray conglomerate as before, with some sandstone	6	0	
Dark gray shaly sandstone	10	0	
Greenish-gray conglomerate as before	2	0	
Greenish-drab sandstone	1	0	
Black shale	3	0	
Greenish-drab sandstone	0	6	
Black flaky argillaceous shale weathering to a light gray clay	0	6	
Greenish-gray sandstone with indications of *Stigmaria*	0	6	
Greenish-gray conglomerate, as before	0	3	
Grayish-drab sandstone	3	0	
Coal	0	0½	Small coal seam
Greenish-drab sandstone with uncertain indications of *Stigmaria*, with greenish-gray conglomerate at the bottom	2	6	
Black argillaceous shale with much iron pyrites	2	6	
Greenish sandstone, mottled with red, probably from weathering,	15	0	
Reddish sandstone, in some parts approaching to a drab; the reddish colour is perhaps due to weathering	20	0	Red sandstone.
	114	3½	

The colour and character of some of the strata of this section induce the supposition that the mass may belong to a lower horizon than the neighbouring strata on the south side of the Fulling-mill fault, though still to be classed with the Productive measures; and it may have been brought into the position which it occupies by some entanglement with the South upthrow fault.

Red rocks, west of East River.

No strata known of a certainty to belong to a lower subdivision of the Carboniferous group than the Productive measures have been as yet observed along the South fault, between these and the Devonian series, though it is supposed that some red rocks which Mr. Hartley has noticed on the west side of the East River may possibly be such. It is to be remarked, however, that these red rocks appear to have the same eastward dip as the undoubted Productive measures above them, in so far as the McLeod coal seam may be taken as guide; and they may represent a deeper portion of the Productive measures than seen elsewhere in this coal field, with the exception of the New Glasgow conglomerate.

New Glasgow conglomerate.

No rocks having the typical character of this conglomerate appear to have been brought to the surface by either the South or the East fault, or by Mr. Hartley's West fault. This does not, however, disprove their possible presence beneath the whole of the Productive area abutting against these faults and constituting the base of Dr. Dawson's Middle Coal formation, as inferred by Mr. Hartley.

Coal seams above conglomerate.

This inference seems to be supported by the presence, immediately on the summit of the conglomerate, of the coal seam worked by Mr. William Fraser (Moose) for the burning of his limestone, and another said to overlie it; and although the occurrence of these is not strengthened by the known existence of any of the larger workable coal seams in the Pictou synclinal, the deposits of which have yet to be examined by the officers of the Survey, it would not be surprising to find, in a country apparently so broken by great dislocations, that the absence of the larger seams may be due to a structure resulting from some of these faults, of as important a character as those affecting the productive part of the field above New Glasgow.

Total thickness of Carboniferous rocks.

The total thickness of the Carboniferous rocks of Nova Scotia, as measured by myself at the Joggins in 1843 is about 14,700 feet. The Pictou series, in so far as our examinations have gone on the present occasion, is in ascending order as follows:

	Ft.	Ft.
Millstone Grit rocks, according to Mr. Hartley's Section 1, without any allowance for the East River series of Section 2, which may be an addition wholly or in part.....		3773
New Glasgow conglomerate, as measured on the east side of the East River.....		1600

			Ft.	Ft.
Productive coal measures:				
Measures on the west side of the East River, according to Mr. Hartley's Section 4			2453	
Measures on the east side of the East River:				
	Ft.	Ft.		
Black shales above Mr. Hartley's Section 4		1000		
Arenaceous measures of this Report.				
Section 3, Division C	924			
Section 2, Division B	819			
Section 1, Division A	223			
Strata above A	148			
		2114		
			3114	
				5567
				10840

When it is considered that in the sections above given on both sides of the East River we do not in any case, with the exception of the New Glasgow conglomerate, suppose that we have attained either the bottom or the top of the series to which it belongs, and that the subdivisions at the summit and at the base of the whole Carboniferous group are wanting, though deposits belonging to them are not far removed from the district examined, it seems probable that the volume assigned to the Carboniferous rocks at the Joggins will be fully maintained in the Pictou region.

I have the honour to be,
Sir,
Your most obedient servant,

W. E. LOGAN.

REPORT

OF

MR. EDWARD HARTLEY, F.G.S.,

ADDRESSED TO

SIR WILLIAM E. LOGAN, F.R.S., F.G.S.,

DIRECTOR OF THE GEOLOGICAL SURVEY.

MONTREAL, 30th November, 1869.

SIR,—In accordance with your instructions of July, 1868, I devoted the remainder of the season of that year to the exploration of that portion of the coal field of Pictou, Province of Nova Scotia, which lies to the west of the East River, and now have the honour to present to you the following Report. Having been made aware that my investigations were to be more especially devoted to the productive portion of the measures, no detailed examination of the older and outlying rocks has been made, except in so far as seemed necessary for the proper definition of the limits of the productive coal area. My description of such rocks will, therefore, be somewhat incomplete. The presence of numerous faults or dislocations of strata, throughout this region, combined with the fact that it is covered with an unusual quantity of drift, renders accuracy in the preparation of sections and in the mapping of the outcrops of coal seams, a difficult task, and in many places the facts which it has been possible to obtain, will only enable me to show the general structure.

In the preparation of this Report, and of materials for a map, I have been greatly assisted by the records of various mining companies and of individuals owning or working the coal areas of this section, also by private and public railway surveys, land surveys, and in the case of working collieries, by such underground plans as I have been able to procure.

Acknowledgments for assistance.

I would here acknowledge the many courtesies received by me from those whom I have met in the course of my examinations. In all cases the fullest information has been granted, for which my sincere thanks

are due and I would especially acknowledge my obligations to the following gentlemen, for the information they have so freely given me:

Mr. H. Crosskill, Assistant Provincial Secretary; Mr. Avard Longley, Chief Commissioner of Railways of the Province; Mr. J. Rutherford, M.E., Provincial Inspector of Mines; Mr. W. A. Hendry, Deputy Commissioner of Crown Lands; Mr. James Hudson, M.E., Chief Manager General Mining Association of London; Mr. Jesse Hoyt, General Agent of the Acadia Coal Company of New York, U. S.; Mr. James Dunn, General Agent of the Intercolonial Company of Montreal; Mr. Truman French, Agent of the Nova Scotia Coal Company; Mr. J. P. Lawson, Mining Engineer, New Glasgow; Mr. J. B. Moore, Contractor for the Intercolonial Coal Company's railway; Messrs. Hanning, Civil Engineers, in charge of the construction of the same railway; Mr. William Barnes, Mining Engineer of Halifax; Mr. R. G. Haliburton, Col. R. B. Sinclair, Mr. L. R. Kirby, of Halifax; Mr. Daniels, of Pictou Mining Company; Mr. W. B. Leather, C. E., of New Glasgow; Mr. A. P. Ross, of Pictou; and Mr. J. Weir, of Pine-tree Brook.

Especial attention is called to the kindness of Messrs. Hudson, Hoyt and Dunn. At the Albion mines I have not only had Mr. Hudson's permission to examine and copy many valuable records and drawings, but he has presented the Survey with complete copies of his extensive underground plans, copies of drawings and specifications of machinery, and of private surveys made for the General Mining Association. By his permission, most satisfactory information was given me in my examination of the machinery by Mr. Thomas Blenkinsop, engineer, and of the underground work by Mr. William Hall, underviewer, and both of these gentlemen I would especially compliment on their admirable management of the works under their charge. I would also remark that to the skill of Mr. Thomas Rutledge, of the same company, we are indebted for the admirable set of drawings presented by Mr. Hudson.

At the Acadia collieries also, I have been allowed by Mr. Hoyt full access to the company's records and plans, and am indebted to him for the aid of men, and for much verbal information useful in my survey. Information concerning machinery and underground work, has been freely supplied by Mr. William Blacker, general overman, as also much information of a general character. I would also acknowledge courtesies of a general character received from Mr. J. W. Clendenning of New York, President of the Acadia Coal Company, who was kind enough to allow me office room in the company's building. In the examination of the Intercolonial Company's works and area, I have been materially aided by the courtesy of Mr. Dunn, who furnished plans, records and information. By his instruction, Mr. James Wilkes, underviewer, and Mr. Joseph

Richardson, underground overman, have also given me full information concerning machinery and underground work. I have also been assisted by plans of the railways by Mr. Moore, and a record of pits and borings by Mr. Barnes.

The area examined is included between the East and Middle Rivers of Pictou, and extends laterally from the Conglomerate ridge, a prolongation of Fraser's Mountain on the north of New Glasgow, to the Fox-brook road between Coal Mines and Hopewell villages. The rocks observed may be included under the following heads: Area examined.

1. Pre-Carboniferous.
2. Millstone Grit.
3. New Glasgow conglomerate.
4. Productive coal measures.

Rocks observed

These rocks I now propose to describe, and will then treat of their distribution in this region.

1. PRE-CARBONIFEROUS.

Pre-carboniferous.

Between the East and Middle Rivers, on the northern ridge, there appears a series of metamorphic rocks, unconformable to the overlying Carboniferous, consisting of quartzites, felsites, altered slates, and conglomerates, in which I could find no distinguishing fossils. This series has however been observed by Dr. J. W. Dawson, and in his *Acadian Geology* he states that they are "probably of Devonian age." * Dr. J. W. Dawson.

Some of these masses are quartzites, extremely tough and compact, of colours varying from dark sap-green to blackish-green, and weathering to a rust-brown. Others are quartzites of similar colours, weather opaque yellowish-white, and appear quite free from iron; while others still are of a dark olive-green, and weather to a very dark blackish-brown. Quartzites.

Felsites varying from pistachio-green to olive-green, and weathering deeply to a rust-brown, are also found. These appear to be brecciated wherever met with, and although compact are always much shattered. Felsites.

A large portion of the rocks consist of altered slates, ranging in colour from dark olive-green to dull greenish-grey, and weathering from an opaque white to a rust-brown. It is difficult, in many cases, to distinguish between the slates and quartzites; in fact they seem to pass into each other by imperceptible gradations. Altered slates.

Two descriptions of conglomerate, and possibly a third, are associated with the series. The first is one in which both cement and pebbles are of a greenish-gray colour, and so nearly alike in hardness that in breaking a mass the pebbles and matrix are fractured evenly across. This rock is Conglomerates.

* Acadian Geology, p. 319 of second edition.

extremely hard and tough, and appears to pass into quartzite by a gradual diminution of the pebbles, which are themselves quartzite of a slightly lighter tinge than that of the silicious cement. The second conglomerate is seen but in one locality, on McCulloch's Brook, where it forms a bed of some twenty feet in thickness, but it is so much injured by weathering that scarcely more can be said of it than that some of the pebbles are of a vermillion red jasper, with a cement weathering to a bright brick-red.

Limestone of Waters's quarry

But one band of limestone of this series has come under my observation. This is seen at Waters's limestone quarry, at the end of the Smoky-town road, where it appears to be about twenty feet in thickness, included within quartzites and altered slates. This limestone is of excellent quality, and is of a white or bluish-white color, with a tinge of ochre-yellow in the cracks; it weathers to a dead white with a porcellanous lustre, the edges of weathered specimens showing some thin laminæ in relief, giving a surface resembling that of an oyster-shell.

Devonian ridge.

These rocks form a ridge on the north of that portion of the coal field which has been examined, and going west are first met with about a mile from New Glasgow bridge, on a considerable rise of ground known as Waters's Hill, and thence scattered exposures and the general character of the ground indicate their presence on this hill as far west as the Intercolonial Company's railway. Waters's limestone quarry is on the summit of this hill, and besides the limestone the green felsites are well exposed. The dip appears to be S. 17° W.* <40° but the measures are disturbed by a fault. In the railway cutting at the west end of the hill good exposures are met with of the quartzites and greenish conglomerate, with a general westerly dip at high angles, but the true stratification is rendered very obscure by numerous dislocations and irregular cleavages throughout the whole mass. From the railway bridge over Waters's Brook the altered slates and conglomerates are well exposed in the cliffs forming the banks of McCulloch's Brook all the way down to its junction with the Middle River. Here, with a direct breadth of about one-third of a mile northward from the junction, and bounded on each side by faults separating them from the newer strata, the rocks of this series cross the Middle River, on the left bank of which they form a low ridge, and on the mill-pond of the axe factory in that neighborhood occur the most western exposures that have been examined.

Millstone Grit.

2. MILLSTONE GRIT.

From widely extended examinations of the Carboniferous rocks of this Province, Dr. J. W. Dawson, in his *Acadian Geology*, has subdivided

* The bearings in this Report are astronomical, the variation for magnetic north being 23° 15′ W. See note p. 6.

this system in Nova Scotia, into five "subordinate groups or formations," as follows, in descending order:*

Dr. Dawson's classification of Carboniferous rocks.

"1. *The Upper Coal formation*, containing coal-formation plants but not productive coals.

"2. *The Middle Coal formation*, or coal formation proper, containing the productive coal-beds,

"3. *The Millstone-grit Series*, represented in Nova Scotia by red and gray sandstones, shales and conglomerates, with a few fossil plants and thin coal seams, not productive.

"4. *The Carboniferous Limestone*, with the associated sandstones, marls, gypsums, etc., and holding marine fossils recognised by all palæontologists who have examined them as Carboniferous.

"5. *The Lower Coal measures*, holding some, but not all, of the fossils of the Middle Coal formation, and thin coals, not productive, but differing both in flora and fauna from the Upper Devonian, which they overlie unconformably."

Subdivisions wanting.

Provisionally adopting the above nomenclature, it would appear that the Carboniferous rocks which I have here met with, are all referable to the Middle Coal formation and the Millstone Grit. Subdivisions 1, 4, and 5, are wanting throughout the region examined, and in some places the unconformable Devonian rocks appear to encroach on the base of the Middle Coal formation without the presence even of the Millstone Grit.

Red, green and gray sandstones limestones and conglomerates

The Millstone Grit is here represented by a considerable mass of red, green and gray sandstones and arenaceous shales with mottled sandstones, of limestones more or less pure, and of coarse and fine conglomerates, the whole manifestly underlying the Middle or Productive coal formation. This will be best described by two sections of strata belonging to the series, which, as now given, are to be considered as representing the larger rock masses rather than the detailed strata of this subdivision; but as the Productive coal measures, where their limits are accurately known, always seem to be separated from this series by faults, while in some places at least, the subdivisions are unconformable with one another, it would not only be impossible to give a section graduating upward into the Productive measures, but it would also be imprudent to hazard an opinion as to the exact horizon which the sections occupy in the Millstone Grit.

Faults.

The first of these sections occurs on McLeod's Brook, lying to the west of the coal field, and affords a fair representation of a considerable portion of these rocks; but as the exposures, though frequent, are not continuous, it is to be regarded only as an approximation. The strata are given in descending order.

* Acad. Geol., second edit. p. 129 et seq.

SECTION 1.

Measures on McLeod's Brook.

MEASURES ON McLEOD'S BROOK FROM GAISLOCH ROAD TO MIDDLE RIVER ROAD.

	Feet.
1. Reddish-grey, brick-red, and mottled sandstones in alternations; some bands of about an inch in thickness are a green conglomerate with quartzite pebbles	
2. Red sandstones	450
3. Greenish-drab sandstones, weathering red; some bands are red throughout.	210
4. Reddish-brown sandstones	325
5. Mottled Indian-red and light yellow sandstones tinged with brown; the predominating colour is Indian-red, the yellow portions being usually only from a quarter to a half inch in diameter, and sometimes assuming a greenish tinge. This mass contains some bands of from three inches to two feet thick, entirely of red sandstone	380
6. Red fine grained flaggy sandstones, interstratified with occasional thin bands of fine conglomerate. The mass is partly concealed	100
7. Greenish-drab red-weathering sandstones, holding thin bands of a greenish conglomerate, with pebbles of quartzite up to one inch in diameter. The sandstones contain many arenaceous plant casts, some of them three inches in diameter, all being indeterminate	600
8. Brick-red shaly sandstones and arenaceous shales in alternating light and dark beds	50
9. Reddish-brown fine grained heavy bedded sandstones, not well exposed	420
10. Chocolate-brown and brick-red shaly sandstones in alternating bands	460
11. Brownish-red coarse brown-weathering conglomerate	100
12. Brownish-red coarse flaggy sandstone similar to the last	45
13. Red coarse conglomerates weathering dark chocolate-brown, holding quartzite pebbles up to six inches in diameter, and containing lenticular masses of coarse greenish-drab rusty-weathering sandstone	40
14. Greenish-drab coarse conglomerates, alternating with coarse greenish-drab flaggy sandstones (tile-stones) in beds of from a quarter to half an inch thick, holding many indeterminate black plant casts in the partings.	20
15. Coarse conglomerates, with pebbles up to an inch and a half in diameter, composed entirely of a green quartzite and altered slate, in a coarse argillo-arenaceous cement, the whole of a green or greenish-drab colour	13
16. Red sandstones, varying in colour from chocolate-brown to Indian-red; as a rule they are fine grained, and show many carbonized plant casts, around which, for about the twentieth of an inch, the colour of the sandstone is changed to a light lemon-yellow, as if from deoxydation of peroxyd of iron	140
17. Coarse conglomerates of a rust-brown colour, tinged with green; they have a silico-ferruginous cement, and hold pebbles of green and black quartzite, altered slate, and a few vermillion-red jasper pebbles; quartzite and slate pebbles reach eighteen inches in diameter and predominate; they have imperfect cleavage with the bedding. The whole are deeply weathered to a rust-red, and poorly exposed	200
	220
	3773

The second section is seen well exposed on the East River, between the Culton farm and the bend of the river above McKay's Brook, south of the Albion mines. It is also in descending order.

SECTION 2.

MEASURES ON EAST RIVER ABOVE THE ALBION MINES.

	Feet.	Measures, East River above Albion mines.
1. Gray greenish-drab and Indian-red fine grained sandstones, interstratified in beds of from one to three feet in thickness	100	
2. Indian-red compact sandstones, with partings showing many small scales of mica. The rock weathers greenish and is much split with cleavage planes	170	
3. Dark Indian-red arenaceous shale	10	
4. Green compact sandstones with micaceous partings, interstratified with several bands of fine grained compact red sandstone	50	
5. Indian-red compact and shaly sandstones in alternations	140	
6. Red highly calcareous sandstones, which in weathering become mottled with patches of greenish-gray	230	
7. Chocolate-brown shaly fine grained non-calcareous sandstones	16	
8. Red and green sandstones in alternate beds of from five to eight feet thick.	47	
9. Indian-red compact calcareous sandstones	160	
10. Red shaly sandstones. This mass contains several patches or lenticular beds of conglomerate with a red argillo-calcareous cement holding green quartzite pebbles up to three-quarters of an inch in diameter. The thin shaly beds show ripple-mark	25	
11. Sap-green very compact and tough fine grained calcareous sandstone	6	
12. Green and greenish-gray fine grained compact sandstones, much split with cleavage planes	18	
13. Red compact sandstone	45	
14. Greenish compact sandstone	10	
15. Red and greenish sandstones in alternating bands	40	
16. Red fine grained non-calcareous sandstone, with some shaly beds	315	
17. Whitish-green coarse sandstones, which at the base become very coarse and pass into a calcareous conglomerate varying from two to six inches in thickness with limestone pebbles up to one-third of an inch in diameter	20	
	1402	

The lower portions of the Millstone Grit hold beds of ferruginous limestone, their thickness varying, where examined by me, from five to twenty feet, the general character of which may be exemplified by that of one seen on the East River, just above McKay's Brook. This is a compact limestone of a white colour, mottled with ochre-red argillaceous patches which weather to a deep chocolate-brown. White limestone.

At McKay's saw-mill, near the New Glasgow and Hopewell road, occur masses of an impure limestone of a deep Indian-red colour, weathering chocolate-brown, mottled with patches of a greenish tinge; of a coarse light greenish-drab rusty-weathering sandstone; and of a peculiar calcareous conglomerate or nodular limestone of a greenish-grey colour, weathering brown, the pebbles or nodules of limestone varying from one eighth to one half of an inch in diameter. Impure limestone. Nodular limestone.

Not far west from New Glasgow there are narrow exposures of strata belonging to this formation, but as these are believed to exhibit a want of

conformity with the formation which is to follow they will be more particularly alluded to further on. Other exposures occur further to the west on the south flank of Waters's Hill, and on McCulloch's Brook, and it seems probable that these may belong to outlying patches resting on the Devonian series.

Outlying patches.

These apparently isolated portions seem to dip to the south and south-west, pointing to the Productive coal measures but a short way in front of them, from which, however, they are separated by a great fault, and they may have originally belonged to a continuous mass rising from beneath the coal measures on the north side of the synclinal in which these are situated.

Fault.

Probably derived from such isolated portions of Millstone Grit are many boulders of mottled-red and green sandstone found in pits and cuttings near the Smoky-town road, and beneath a red drift on the Intercolonial Company's railway, just south of the bridge over Waters's Brook, a conglomerate of this series is met with holding pebbles of greenish quartzite and white quartz.

Largest area of Millstone Grit.

By far the largest area occupied by the rocks of this formation, in so far as examined, is bounded on the west by the Middle River, on the south by the Fox-brook road and extends eastward to the old Hopewell road as far as McNaughton's mill-pond on the upper part of McCulloch's Brook, and a straight line coinciding with a fault which runs N. 33° W. from the mill-pond through the village of Westville to a point in the neighbourhood of McCulloch's Brook about one half mile from the Middle River.

McLeod's Brook.

In this area McLeod's Brook, which joins the Middle River nearly half a mile above Alma mills, has a general upward course, somewhat oblique to the strike of the strata, of about S. 20° E. as far as Oliver's mill, a distance of two miles and three quarters, crossing the Gairloch road about a mile short of this measure. The strata between Alma mills and Oliver's mill appear to be arranged in two synclinal forms, a deep one on the north of the Gairloch road bridge, the east and west axis of which would approach the Devonian rocks already described, and a shallow one to the south, the axis of which may be half way to Oliver's mill.

Oliver's mill.

Synclinals.

Rocks of Section 1.

The rocks which have been given in Section 1, form the south rise of the north synclinal, where they have a direct transverse breadth of about a mile and a quarter, with angles varying from 20° to 43°, and a portion of these may be repeated in the south synclinal. The strata exposed at Oliver's mill-dam dip S. 57° W. $< 86°$, and appear to be the vertical measures of a considerable dislocation, and about a quarter of a mile to the south of this mill a great east and west upthrow fault is supposed to run through the country, but south of its position the strata of this formation appear to constitute the subsoil for a mile and a-half to the Fox-brook road. It is probable that these may be lower than the strata of the McLeod's Brook sec-

Faults.

tion, but whether they are so or not, Section 2, exposed on the East River from this dislocation to the turn of the river above McKay's Brook may be considered as representing them wholly or in part. The direct breadth of the strata included in this section is about thirty chains in a bearing N. 10° E., with angles of inclination varying from 40° to 60°, the top of the exposed section being at the line of the fault which would cross the Nova Scotia railway about one and a-half miles south of Coal Mines station.

3. NEW GLASGOW CONGLOMERATE.

New Glasgow conglomerate.

On the west bank of the East River, at the New Glasgow bridge, there is exposed a series of coarse and fine conglomerates with occasional sandstones of colours varying from Indian-red to chocolate-brown. As a rule the coarser conglomerates are more common at the bottom, the finer at the top; but they both consist of the same materials, with a difference only in the size of the pebbles, which in the finer conglomerates do not exceed a quarter of an inch in diameter.

Pebbles from Millstone Grit.

In the coarser beds however the inclosed masses are of all sizes up to three feet in diameter, and they are, with very few exceptions, derived from the rocks of the Millstone Grit, those of red sandstone and red shale predominating, while with them all the green, greenish-drab, chocolate-brown and mottled grey and brownish sandstones, with calcareous conglomerates and nodular and other limestones, have been recognised as constituting the mass. The only other pebbles are a few of quartzite and conglomerate of the Devonian rocks.

Pebbles from Devonian rocks.

Calcareous matter.

These masses are inclosed in an argillo-arenaceous cement, holding a good deal of calcareous matter, which sometimes shews itself as a white crystalline calc-spar holding the pebbles together. The colour of the cement is an Indian-red, and this has served more or less to tinge the whole mass. The sandstones are exemplified by two beds of five feet each, of a shaly character and brick-red colour, which are seen at a distance of seventy and 120 feet respectively from the base of the section; but thinner lenticular masses and partings of red and dark-brown colours are common.

Breadth exposed at new Glasgow bridge.

These rocks are visible along the margin of the river for a distance of 300 yards, with a direct breadth across the stratification of 610 feet, with a general dip of N. 10° W. $< 35° - 50°$, giving a thickness of 450 feet; but on the opposite side, as you are aware, similar rocks stretch much farther down the river and greatly augment the volume of the formation to which the locality has served to give a name.

Another exposure of these rocks occurs at Alma mills bridge on the Middle River, and the following is a detailed section of them in descending order :

Section 3.

Measures Alma mills bridge.

Conglomerates at Alma Mills Bridge, Middle River.

	Feet.
1. Red conglomerates and red shaly sandstones alternating in beds of from two to six inches thick; the sandstones vary in colour from Indian-red to chocolate-brown, and the matrix of the conglomerates is a calcareo-argillaceous sand containing besides Millstone Grit pebbles, many of green quartzite and altered green conglomerate	13
2. Measures concealed, probably the same	37
3. Red sandstones and conglomerates alternating as in 1	163
4. Measures concealed	13
5. Red very coarse conglomerates alternating with red coarse arenaceous shales; some pebbles in the conglomerates are six inches in diameter	80
7. Indian-red very compact sandstone, much split with cleavage planes	30
8. Red coarse conglomerate with pebbles of various sizes up to two inches in diameter	3
9. Brick-red arenaceous shales and thin bedded sandstones	39
10. Measures concealed	37
11. Red very coarse conglomerate, holding many pebbles of Devonian rocks varying in size up to eighteen inches in diameter	72
12. Red coarse conglomerates with thin lenticular beds and partings of a brick-red coarse grained flaggy sandstone	13
13. Red fine conglomerates with red alternating arenaceous shales. The fine conglomerates hold Millstone Grit pebbles, mostly of red and dark brown sandstones; they have a brownish-red calcareo-argillaceous cement	9
14. Red coarse conglomerate with pebbles up to about three inches in diameter, in a strongly calcareo-argillaceous cement in many places showing scales of white crystalline calc-spar	4
15. Brick-red flaggy fine grained sandstones	16
16. Measures concealed	16
17. Red coarse conglomerate	5
18. Light ochre-red arenaceous shale	5
19. Red shale and red very fine conglomerates interstratified	5
20. Brownish-red shales and sandstones interstratified	29
21. Measures concealed	36
22. Red coarse conglomerates, with pebbles up to eight inches in diameter (not well exposed)	193
23. Red very coarse conglomerates with pebbles of all sizes up to twenty-six inches in diameter, with occasional lenticular layers of brownish and brick-red arenaceous shale of one or two inches in thickness	283
24. Dark chocolate-brown shaly sandstones, and dark red fine conglomerates with pebbles of half an inch in diameter	34
25. Measures concealed	23
26. Red shales and brick-red coarse soft sandstones alternating with one another	24
27. Red shales and red sandstones of a similar character, partially concealed	21

	Ft.
28. Red coarse conglomerate with pebbles up to two inches and a half in diameter	4
29. Measures concealed, probably red shale	15
30. Red coarse conglomerate	15
31. Brick-red and chocolate-brown sandstones in bands of about a foot thick.	10
32. Red coarse conglomerate with pebbles up to six inches in diameter	27
33. Measures concealed	50
34. Dark Indian-red arenaceous shale	26
35. Measures partially concealed, probably red shale	22
	1,372

The conglomerates of this section are situated on the north side of the narrow mass of Devonian rocks which has been previously described. The exposures extend from a little above the bridge 580 paces along the margin of the river, nearly at right angles to the strata, which dip S. 20°—30° E. with an inclination gradually diminishing from 74° to 54° as we approach the Devonian strata. These present themselves within twenty paces of the highest conglomerate bed, with probably a fault between. Going northward from the bridge, after a concealed interval of somewhat under half a mile, possibly underlaid by Millstone Grit deposits, we meet with a similar series of conglomerates, with an opposite dip and more moderate inclination, N. 10° E. < 5°—25°, which has a breadth of nearly a mile, giving a thickness of about 1400 feet. We have thus good evidence of an anticlinal form. The north limit of the Devonian rocks bears about N. 61° E., which being oblique to the strike of the conglomerates permits a greater extension eastward of the north than of the south slope of the anticlinal; and it is questionable whether the north side of the Devonian rocks runs so far in the bearing given as to completely interrupt the summit of the conglomerates on the north side. The strike of the summit, as determined by such exposures as have been met with, would seem to carry it to an uninterrupted junction with the summit of the north-dipping conglomerates of New Glasgow bridge. These rocks would thus appear to be connected with an anticlinal form between a northern synclinal on the one hand, lying between New Glasgow and Pictou, and a southern one on the other holding the Productive coal measures. Between the conglomerates and the coal measures, as distributed in this part of the country, there runs a great dislocation gradually cutting off the southern slope of the former in its course towards New Glasgow, where the northern slope alone remains; but on the north side of the dislocation, towards the Middle River, the narrow mass of Devonian rocks is singularly thrust up through the exposed south slope of the conglomerates, without apparently in any way affecting the anticlinal form except as being a protruded mass.

South dip.

Devonian strata.

Millstone Grit.

Anticlinal form.

Strike of summit.

Synclinals.

Devonian thrust up.

The New Glasgow conglomerate thus occupies a position intermediate between the rocks of the Millstone Grit, of the ruins of which it is made up,

Base of productive measures.

and the Productive coal measures, and may be considered as the base of Dr. Dawson's Middle Coal formation.

In tracing this conglomerate west from New Glasgow to the Middle River, it appears along the northern flank of Waters's Hill to directly overlie the altered Devonian rocks of that locality, and to be partially reduced in thickness by unconformity. As no contacts are seen however this appearance may be produced by a series of dislocations bringing up the lower rocks and obscuring the Millstone Grit, which in other portions of the region intervenes between this series and the New Glasgow conglomerate.

Discordance with Millstone Grit.

But if we have here an evidence of a want of conformity between the Carboniferous and Devonian rocks, nearer New Glasgow there appear to be indications of a discordance between two of the subdivisions of the Carboniferous rocks themselves. On the north side of the old road to Frazer Ogg's quarry, running S. 77° W. from the Hopewell road near New Glasgow bridge, and on a small water-run skirting the base of the escarpment of the New Glasgow conglomerate, there is seen just north of the great fault which has been mentioned above, a short section of the red and greenish sandstones, red shales and nodular limestones of the Millstone Grit series dipping N. 47° E. < 67°, and evidences of the same rocks with a similar resulting strike are displayed for 200 paces north-westward. Fifty paces to the northward of this section we have the base of the New Glasgow conglomerate dipping N. 3° W. < 30°. These exposures would seem to give direct proof of the unconformity of the conglomerate with the rocks of the Millstone Grit, which unconformity we should naturally have expected from the presence of pebbles derived from rocks of the latter division in the former.

Productive coal measures.

4. PRODUCTIVE COAL MEASURES.

In describing the Productive coal measures, I shall first give the column of strata containing the Albion coal seams, as represented at the Albion and Acadia mines near the East River, with some remarks upon the same series of rocks at other points, and the changes which they undergo, illustrated by short sections.

Main and Deep coal seams.

The coal seams of the Pictou region are widely known, especially the Main and the Deep seams, respectively thirty-six and twenty-four feet in thickness. On the west side of the East River, the Main seam is the highest one worked, being succeeded in ascending order by a great mass of measures barren of coal seams, known in the region as the *black shales*, from the character of the rocks composing it on the East River and at the first series of pits at the Albion mines; though, as will be seen hereafter, partially represented in other parts of the region by sandstones and fireclays alternating with shales.

Black shales.

The following section will approximatively represent the column of strata at the Albion and the Acadia Mines on the East River, and on the Acadia Company's railway. The materials are taken from pit records, where practicable, supplemented by the few exposures of which I have been able to obtain the exact position in the series.

Defects of record

It is to be regretted that the value of pit records is greatly injured by the fact that usually a mere general character is given to the mass mentioned, as for instance *rock*, *sandstone*, *shale*, *fireclay*, without a statement of the important characteristics of colour and texture. To repair this defect, I have, where possible, examined the material taken from the pits, in company with men employed in sinking them, and will, in such cases, give my own descriptions, taking the record merely for thicknesses.

Pit debris examined.

In many cases, where numerous alternations of strata have been met with, the pit *débris* is so much mixed, that an attempt to separate the bands by means of it might lead to error, and in such cases the record is given word for word, as received, a reduction to the true thickness at right angles to the stratification being the only change made.

Authorities.

Down to the Third seam I am indebted to the records of the General Mining Association, as kept by Mr. Henry Poole, while manager, and by Mr. James Hudson, the present manager; below the Third seam and above the Oil coal, the detailed sections are from the Acadia Company's record, as kept by Mr. Hoyt.

Highest coal seam on W. side of East River.

The section commences with the highest seam of which the exact position is known, as proved in a pit sunk by Mr. Hudson, on the bank of Coal Brook, and the measures are given in descending order.

Section 4.

Albion section.

Measures at the Albion and Acadia mines.

	Ft.	In.	Ft.	In.	
Three-and-a-half feet seam.					
1. Coal and brown carbonaceous shale mixed	2	2			Three-and-a-half feet seam.
Coal, said to be good, not exposed	1	4			
			3	6	
2. Measures partly concealed, the lower part black semi-carbonaceous shale, with a light brown streak	70	0			Black shales.
3. Black carbonaceous shale, very compact, giving a nearly black streak	6	0			
4. Black argillaceous and carbonaceous shales in alternating bands, not well exposed	254	0			
5. Brown carbonaceous shale	182	6			
6. Black semi-carbonaceous shale	66	2			
7. Brown carbonaceous shale	19	6			
8. Black argillaceous shale	9	5			
9. Brown carbonaceous shale	521	0			
			1128	7	

		Ft.	In.	Ft.	In.
Main seam.	*Main coal seam.*				
	10. Coarse coal	1	4		
	11. Good coal	4	3		
	12. Ironstone band	0	2		
	13. Good coal (worked at the Foord pits)	20	6		
	14. Coarse coal *	8	4		
				34	7
	15. Dark *Stigmaria* underclay; the thickness is not stated in the record; that here given is not fully exposed	1	9		
	16. Black argillaceous shales, with many bands of ironstone of from one-half to three-quarters of an inch in thickness, and at least two bands of arenaceous shale of about two or three inches thick, of a dark gray color	144	6		
	17. Brown carbonaceous shale†	1	10		
				148	1
Deep seam.	*Deep or Cage-pit coal seam.*				
	18. Bad coal	0	2		
	19. Good coal	3	7		
	20. Ironstone	1	1½		
	21. Coal of fine quality	3	5½		
	22. Shaly coal	0	8½		
	23. Good coal	3	9		
	24. Coarse coal	0	11½		
	25. Good coal	3	4		
	26. Inferior coal‡	5	10		
				22	11
	27. Measures concealed, and no pit records	98	0		
	28. Black carbonaceous shale	8	8		
				106	8
Third seam.	*Third seam.*				
	29. Coal, said to be good			5	7
	30. Measures concealed, probably shales, and fireclays with thin bedded sandstone	61	2		
	31. Fireclay	9	1		
	32. Hard sandstone	1	0		
	33. Soft sandstone	4	1		
	34. Fireclay	6	4		
	35. Black argillaceous shale	4	6		
	36. Fireclay	2	9		
	37. Black argillaceous shale	0	10		
	38. Fireclay	2	3		
	39. Hard sandstone	1	4		
	40. Soft arenaceous shales	6	2		
	41. Fireclay	6	2		
	42. Black semi-carbonaceous shale	[illegible]			
	43. Hard sandstone	0	5		
	44. Black argillaceous shale	5	3		
				113	10

* Nos. 5—14 are reduced from the Foord pit record.

† Nos. 16—17 are taken from Mr. Hudson's record of the Dalhousie downcast shaft.

‡ Nos. 18—26 are taken from Mr. Poole's journal.

	Ft.	In.	Ft.	In.	
Purvis seam.					Purvis seam.
45. Coal coarse and impure; it increases to five feet six inches one mile west			2	8	
46. Underclay with *Stigmaria*, a light colored fireclay	0	10			
47. Compact gray sandstone	4	5			
48. Fireclay	5	2			
49. Hard sandstone	2	7			
50. Fireclay	19	9			
51. Blue (bluish-gray) fireclay	4	0			
52. Compact sandstone	5	7			
53. Blue fireclay	6	5			
54. Compact sandstone	0	5			
55. Shale	0	5			
56. Fireclay	0	4			
57. Compact sandstone	4	2			
58. Fireclay	5	0			
59. Measures unknown	1	6			
60. Black argillaceous shale	7	2			
61. Fireclay mixed with *coal* (?)	7	7			
62. Fireclay with *Stigmaria*	5	8			
63. Bluish-gray flaggy sandstone	2	6			
64. Fireclay	0	3			
65. Gray sandstone	0	8			
66. Fireclay	11	8			
67. Black shale*	2	3			
68. Measures unknown: from poor exposures they are believed to be fireclays and thin beds of sandstone, generally of a yellowish-drab or brown color	31	8			
			130	0	
Fleming seam.					
69. Coal of a fair quality			3	3	Fleming seam.
70. Black carbonaceous shale			4	3	
McGregor seam.					McGregor seam
Upper coal.					
71. Good coal. First Bench	1	9			
72. Dark brown arenaceous fireclay parting	1	0			
73. Good coal. Second Bench	3	0			
Bottom coal.					
74. Impure Coal	1	4			
75. Good coal	0	10			
76. Impure coal	0	8			
77. Good coal	1	0			
78. Black carbonaceous shale	0	6			
79. Good coal	1	6			
			11	7	
80. Measure unknown, said to contain an impure *coal seam* of considerable thickness, not opened	186	0			Impure coal seam.
81. Sandstone	2	8			
82. Fireclay	9	2			
83. Brown fireclay and brown carbonaceous shale	9	2			
84. Black highly carbonaceous very compact shale	4	7			
			211	7	

* Nos. 31—67 are reduced from trial pits Nos. 1 and 2.

		Ft.	In.	Ft.	In.
Stellar seam.	*Oil coal or Stellar coal seam.*				
	85. Good coal	1	4		
	86. *Stellar oil coal*	1	10		
	87. Bituminous shale. *Oil shale bench*	1	10		
				5	0
	88. Underclay not stated, included in the next (89)				
	89. Black carbonaceous shale			15	2
Seam A.	*Seam A.**				
	90. Impure coal			11	0
	91. Yellowish-drab arenaceous underclay, weathering quickly to a light brown colour and holding *Stigmaria*	8	0		
	92. Light brown compact fine-grained sandstone	3	0		
	93. Measures concealed	66	0		
	94. Light brown fine grained very compact rusty-weathering sandstone	3	6		
	95. Light brown fine grained sandstone, split with cleavage planes	30	0		
				110	6
Seam B.	*Seam B.*				
	66. The crop only shows; it has never been opened, but its thickness is probably about			2	0
	97. Measures concealed, apparently light drab fireclays and sandstones			75	0
Seam C.	*Seam C.*				
	98. This has not been proved; it is an impure coal at the crop, the thickness is estimated at			10	0
	99. Light yellowish-drab arenaceous underclay with *Stigmaria*	15	0		
	100. Measures concealed	18	0		
	101. Yellowish compact sandstone with *Stigmaria* (?), weathering brownish-yellow and containing black shaly partings	10	0		
	102. Measures concealed	15	0		
				58	0
Seam D.	*Seam D.*				
	103. Seen at the crop; the thickness is unknown, say			0	6
	104. Measures concealed	5	0		
	105. Purplish or dull claret-red very compact sandstone; one layer is eighteen inches thick	4	0		
	106. Measures concealed; one or two exposures of arenaceous fireclay of a yellowish-drab color are seen	26	0		
				35	0
Seam E.	*Seam E.*				
	107. This is a very small unproved crop, and may be about			0	6
	108. Yellowish-drab sandstones and fireclays alternating with one another, some of the fireclays weathering to a reddish tinge. These beds are partially concealed	23	0		
	109. Claret-red compact fine-grained sandstone, much split in the cleavage planes	3	0		
	110. Light brownish or rust colored fine grained soft sandstone, with false bedding and cleavage joints	5	0		
	111. Light brown sandstone of a similar character, partially concealed	8	0		
				39	0

* Nos. 81—90 are reduced from records. Nos. 91—120 are taken from exposures.

	Ft.	In.	Ft.	In.	
Seam F.					Seam F
112. Impure coal seen at the crop, and from the width of the crop estimated at			4	0	
113. Brownish-yellow arenaceous underclay with *Stigmaria*, passing downwards into a soft crumbling sandstone of the same colour			0	0	
Seam G.					Seam G.
114. Coal not proved, estimated at			2	0	
115. Measures partly concealed, apparently yellowish fireclays	13	0			
116. Measures concealed; the drift shows the *wash* of a coal seam.	11	0			Coal wash.
117. Measures concealed, including two very indistinct crops of *coal seams* of small size	72	0			Two small seams.
118. Brownish-yellow crumbling arenaceous fireclay with *Stigmaria*, immediately overlaid with a little *coal wash*, as if of a coal seam of an inch or two in thickness	7	0			Coal wash
119. Dull claret-red sandstone, very compact and fine grained	7	0			
120. Brownish coarse grained sandstones and arenaceous fireclays alternating with one another, badly exposed, estimated at	40	0			
			150	0	
Total*			2452	11	

Horizontal changes in measures and coal seams.

No single section or column can be given which will fairly represent the measures of the entire coal field, as very considerable changes occur in the character and size of the coal seams, and changes of a remarkable character are seen throughout the field in the rocks. Special descriptions of the coal seams at the different colleries, with one or two pit sections, will illustrate this. Perhaps the most remarkable instance in this coal field of a complete change in the character of the measures is that which occurs in the 400 feet of strata immediately overlying the Main seam, between the Foord pits near the East River and the Forster pit, about a mile to the west. At the Foord pits, as will be seen by reference to the general section, the Main seam is overlaid by upwards 1,000 feet of black and brown shales, the lower portion of which is principally carbonaceous. Tracing this mass of black shales west, on Coal Brook we find the shales less carbonaceous, and many interstratified bands of clay iron-stone are included in the lower portion; at the Dalhousie pits, they are the same, with some arenaceous black shales included; and on the Forster pit railway, some very thin bedded, light drab sandstones become interstratified. No exposures exist between the Dalhousie and Forster pits, but as we go west we may trace, by means of the rocks brought into the underground working by a *crush*, a gradation from argillaceous black shales and iron-stones, through arenaceous black shales and arenaceous light coloured shales with

Changes between Foord & Forster pits.

* Between the Deep and McGregor seams there are but few natural exposures, and as neither the Third nor Purvis seams are open at the present time, the general thicknesses as given, are liable to alteration on future explorations.

black carbonaceous partings, to thin bedded sandstones with similar black or brown argillaceous partings; while at the Forster pit we find the following descending section, including many feet of compact sandstone, often of a pure white colour.

Forster pit section.

Section 5.

Measures intersected in the Forster pit.

		Ft.	In.	Ft.	In.
1.	Dark grey sandstone, the *post* of the miners	13	9		
2.	Yellowish drab fireclay varying to brown	2	3		
3.	Black argillaceous shale		6		
4.	Yellowish-drab fireclay	2	3		
5.	Black argillaceous shale	19	9		
6.	Dark brownish-grey shaly sandstone, passing into argillo-arenaceous shale holding calcareous matter; it weathers soon to a rust-brown colour	8	6		
7.	Bluish-grey argillaceous shale	2	8		
8.	Dark grey sandstones and shales similar to 6	20	2		
9.	White sandstone, sometimes shaly, often compact, in beds of from three to four inches. The shaly portions have some black carbonaceous partings	1	2		
10.	Dark brownish-grey sandstones and shales similar to 6	32	4		
11.	Black semi-carbonaceous shale	81	0		
12.	Brown carbonaceous shale	54	0		
13.	Dark brownish argillo-arenaceous shales. They are composed of interstratified layers of black and white arenaceous shales, very thin and loosely bedded. They are strongly calcareous, and in similar shales in other parts of the field, I have seen small lenticular masses of pure white limestone up to an eighth of an inch in thickness and three or four inches in length	93	4		
14.	Brown carbonaceous shale, the *black bat* of the miners	6	3		
15.	Light grey argillo-calcareous shale, containing a great deal of iron. It weathers to a very bright iron-red on surfaces of deposition, and rust-brown on fractures. Some portions of this mass may prove a workable ironstone	54	0		
				391	11
Main seam.	*Main seam.*				
	Coarse coal	2	3		
	Good coal	2	3		
	Dark brown arenaceous fireclay parting	1	1		
	Good coal	8	9		
	Dark brown arenaceous fireclay	2			
	Good coal. This part is worked	19	9		
				36	10
				428	9

Faults bounding the coal field.

The Productive coal measures in the district under consideration are included between two great upthrow faults on the north and south sides, and they are limited on the west by a third. These faults have already been incidentally alluded to in the description given of the distribution of

the lower rocks. One of the dislocations, to which you have given the name of the North fault, passes through the town of New Glasgow, where, on the west side of the river, it brings the lower portion of the coal measures against a small area of Millstone Grit deposits, just at the base of the New Glasgow conglomerate. Thence it passes in a course of S. 88° W. near to the north-west corner of the General Mining Association's area, in which vicinity it turns more to the south-west, and from the Smoky-town road to the Middle River its course is about S. 72° W. In this bearing, to within a mile of the Middle River, it brings the Devonian series, with outlying patches of Millstone Grit, against the coal measures, but farther on its effect is diminished by the fault forming the western boundary of the coal field. This disturbance it is proposed to designate as the West fault. The general course of this dislocation, and its position, as well as the position of the great southern upthrow which you have named the South fault, have been indicated in the description of the limits of the principal areas of Millstone Grit.

North fault.

West fault.

South fault.

Within these boundary lines the coal measures are arranged in two synclinal forms, the axes of which, about a mile apart, run in a general east and west direction. The first and larger of these will be designated the Albion synclinal. It has perhaps a subordinate undulation near its centre, but the exposures which would seem to indicate this may be brought into place by a considerable fault known to exist in their vicinity. The Albion synclinal extends laterally from the town of New Glasgow to the Albion and Acadia (Fraser) mines, near the East River; and to the south of this is the second trough, to which will be given the name of the Bear-creek synclinal. Both of these are limited at their western ends by the West fault, and while the area of the workable coal in the Bear-creek synclinal is limited to the east by a dislocation, probably not throwing out the lower portion of the coal measures entirely, the Albion synclinal* extends eastward across the East River, beyond the region of my examination.

Albion synclinal.

Bear-creek synclinal.

The only important group of coal seams included in the measures on the west side of the river, is that of the general section (Section 4), and as these seams have been most extensively worked, and are therefore best known at the Albion mines near the East River, it would seem best to take these workings as a starting point in describing the general distribution of the group.

Albion group of coal seams.

Distribution.

From the oldest workings on the west bank of the little branch of the East River the out-crop of the Main seam, which in these workings has a dip of N. 22°—30° E. (or N. 45°—53° E. Magnetic) <18°—23°, crosses

Out-crop of Main seam eastward.

* This is the Middle synclinal, and the subordinate undulation gives the North synclinal of the previous Report.

Pictou Mining Company's slope.

the East River, and curving slightly south-eastward enters the area of the Pictou Mining Company. About half-a-mile in a bearing S. 70° E. from the west bank, a slope was sunk by the company mentioned upon the Main seam; but the coal proving of inferior quality the workings have been abandoned. The dip is here N. 35° E. <19°, and a section of the seam as taken by Mr. Thomas Lawther when in charge of the mine as overman, and given me by him is as follows:—

	Ft.	In.
Shaly coal, known as *strong coal* by the miners	2	0
Coal and black carbonaceous shale	8	0
Shaly coal	2	0
Black carbonaceous shale, with coaly matter in the partings	10	0
Shaly coal, worked	1	0
Good coal, worked	2	0
Shaly coal, worked	1	0
Poor coal, not worked, about	12	0
	38	0

Pit on Grant's farm.

About twenty-eight chains from the slope, in the bearing S. 73° E. and 308 yards from the crop across the strike of the strata, which is here S. 25° E., a pit was sunk 350 feet to the top of the Main seam, and a few feet into the coal, which proved of inferior quality, in consequence of which, after boring through the seam, this shaft also was abandoned. As the strata sunk through in this pit shew a change in the character of the measures between this point and the Foord pits, equally remarkable with that between the Foord and Forster pits, the following section is given after an examination of the pit *débris* in company with Mr. Lawther, who had charge of the sinking, and has furnished the record of the thicknesses of the different beds:—

Section 5.

Measures in pit on Main seam.

Measures intersected in the Pictou Mining Company's pit on the Main seam, Grant's farm.

	Ft.	In.
Black carbonaceous and argillaceous shales in alternating bands; the only fossil observed is *Cordaites borassifolia*	94	0
Dark gray sandstone alternating with white arenaceous shales having black carbonaceous partings, and showing many indeterminate carbonised plants; in some beds the partings exhibit ripple-marks. In weathering, the arenaceous shales do not change their colour, while the sandstones weather different shades of gray, through brownish-gray to dark brown, some bands shewing a reddish tinge. The whole mass contains occasional thin bands of clay ironstone	58	0
Black argillaceous shale	101	0
Dark gray close grained sandstones with white arenaceous shales similar to the second bed of the section; near the middle of the mass a band of dark gray sandstone was sunk through of an exceedingly close grain which weathers to a dull orange-drab	37	0

			Ft.	In.
Black carbonaceous shale			7	0
Dark gray heavy bedded sandstone interstratified with dark gray shaly sandstone having some black carbonaceous partings			14	0
Black argillaceous shale			1	0
Main Seam.	Ft.	In.		
Coarsely laminated coal, known as *coarse coal* by the miners	2	5		
Dark gray fireclay full of *Stigmaria*	2	10		
Shaly coal and black carbonaceous shale	0	6		
Coarse coal	1	7		
Dark gray fireclay with *Stigmaria*	2	4		
Bad coal, bored through	6	7		
Dark fireclay, bored through	3	0		
			28	3
			340	3

Immediately to the rise of this shaft a trial-pit has been sunk on the crop of the Main seam, but beyond this the seam has not been traced southward. In a few chains however it is probably thrown considerably to the eastward by a fault having an east and west bearing and producing an upthrow on the south side. To the south of this fault one coal seam only is known; it is on the land of Mr. Donald McLeod, and with a thickness of eight feet, strikes S. 15° E., the dip being eastward at a moderate angle, but it is not at present known what coal seam of Section 4 this one represents. The dislocation which brings it into place will be designated as the McLeod fault. The McLeod fault. McLeod seam.

In the triangular area between the crop of the Main seam and the dislocation just mentioned, bounded to the west by the East River, only one seam has been opened. It is the Deep or second seam of the Albion group, on the crop of which a trial-pit was sunk by the Pictou Mining Company; but the coal is said to be of very poor quality. Deep seam.

The crop of a seam underlying this is seen on the east side of the Springville road, in a small stream crossing the road about half-a-mile to the south of the crop of the Main seam, but its position in the coal series cannot be stated with certainty at present, as it lies to the south of the McLeod fault. Beyond this disturbance the measures are supposed to turn slightly to the west of south, and then again curving round to a south-eastward strike, they will, if not lost on some dislocation as yet unknown, be finally cut off by the great South upthrow fault of McGregor's Mountain. The westward curve of these measures shows the existence of a shallow synclinal on the eastern prolongation of the axis of the Bear-creek synclinal* presently to be described. Coal seam. South fault. Bear-creek synclinal.

* This synclinal appears to correspond with the South synclinal of the previous Report.

Out-crop of Albion seams westward.

Returning to the west side of the East River, the workable seams from the Main to the McGregor are known near the river bank. The underground workings of the Albion mines prove the exact position of the Main and Deep seams for about one mile and a quarter west from the earliest workings. From these, now known as the Burnt mines, the strike and the angle of dip continue regular to the Dalhousie and Cage pits, where the dip is N. 22° E.<20° at the crop of the Main and Deep seams in the bed of Coal Brook ; thence the line of the crops of these seams turns to a more westerly strike, the dip at the crop of the Main seam to the rise of the Forster pit being about N.<30°. Farther west the strike curves slightly to the south-westward, while the angle of inclination is considerably reduced, the dip at the McKenzie pit on the Deep seam near McCulloch's Brook being N. 23° W.<15°.

Dalhouse and Cage pit.

McKenzie pit.

Third and Purvis seams.

The Third and Purvis seams are known near the river by trial-pits sunk by the Acadia Coal Company, and to the west nearly as far as McCulloch's Brook by the Third seam slope near the north line of the Fraser area, thirty-nine chains from the north-west corner-post; and by the Purvis pit on the north side of the old post road to the Middle River, about twenty-two chains eastward of the McKenzie pit.

McGregor seam

The McGregor seam has been traced from its out-crop on the bank of the East River about 115 chains west by trial-pits and the workings of the McGregor colliery, and a crop on McCulloch's Brook is believed to show the position of the seam still farther west.

Stellar seam.

The most extensive working of the Oil-coal or Stellar seam is from the Fraser mine of the Acadia Coal Company, near the crossing of that company's railway on Coal Brook, from which opening its crop is known eastward to a point near the New Glasgow and Hopewell road, about forty-five chains. Here the out-crop of this seam approaches the run of the dislocation which has been called the McLeod fault, and it is probable that it cannot be traced much farther in a south-east direction. To the west of the Fraser mine the course of this seam has been proved to the Stellar mine or Oil-coal slope on the east bank of McCulloch's Brook, where it dips W. <13°, shewing this position to be near the axis of the anticlinal between the Albion and Bear-creek troughs. The seams and the associated measures which are placed below the Stellar in Section 4 are seen only on the Acadia Coal Company's railway, the lowest appearing in the railway cutting about twenty-five chains eastward from the McCulloch's Brook bridge, immediately to the south of which exposures runs the McLeod fault, bringing up still lower rocks. Their position in the Carboniferous series is as yet not accurately known.

A short distance to the west of McCulloch's Brook, and nearly parallel with its course from the Stellar mine to the McKenzie pit, a considerable

dislocation exists, having a run S. 22° E, with a western downthrow; the extent of this is not exactly known, but it would appear to be about 1600 feet where the crops of the Albion group of seams are lost. This dislocation will be called the McCulloch-brook fault. A short distance to the south of the Stellar mine the break in this fault is considerably increased by that of the McLeod fault. It has already been observed that the measures to the south of the McLeod fault have not been sufficiently examined to enable their horizon to be stated with certainty, and but few exposures exist between this fault and the great South fault; the rocks however, where seen, appear to be light drab and reddish-grey sandstones with many thin beds of black flaky fireclay, some of the sandstones weathering to a deep Indian-red, somewhat resembling the red sandstones of the Millstone Grit series. The general aspect of these strata, however, is not precisely like any mass of rock known to belong to that series, and as the lowest portion of the strata in question, where exposed near the East River, have a resemblance to some beds of yellowish-white sandstone seen on the right bank of the river below New Glasgow bridge, in geological position immediately overlying the New Glasgow conglomerate, we may provisionally consider the rocks in these two places as occupying a proximate horizon, namely that of measures between the conglomerate and the workable coal seams.

McCulloch-brook fault.

Red Sandstones.

Geological horizon.

Between the two bounding faults these strata are arranged in a shallow synclinal form corresponding with that to which, as you have informed me, you have given the name of the South synclinal on the east side, and the same as that designated by me as the Bear-creek synclinal on the west side of the East River.

The McCulloch-brook fault cuts off the crop of the Main seam near a small water run, a few chains to the west of McCulloch's Brook. On the down-throw side of the break the general dip of the measures is changed but little near this point, but on proceeding south we find near the south-eastern portion of the Carmichael area of the Acadia Coal Company that the strata pass over an anticlinal, the dip becoming flat, and then southerly, while in the centre of the eastern portion of the Bear-creek area of the Intercolonial Coal Company the measures again flatten, and finally assume a northerly dip as we go south. The anticlinal near the south line of the Carmichael area is the continuation westward of the form on the north dip of which the Albion mines are situated, while the synclinal is in continuation of your South synclinal, and is the form to which I have given the name of the Bear-creek synclinal.

Break in Main seam.

The strata which are brought up by the fault against the Main seam of the Albion mines are believed to represent a series of black shales above the Three and a-half feet seam at the summit of Section 4, which have been

Three and a half feet seam.

observed elsewhere only to the east of the East River on Potter's Brook. The angles of inclination to the west of the fault are not sufficient to bring the Main seam and those below it to the surface, and therefore in tracing the McCulloch-brook fault to the south-eastward, out-crops of these seams do not appear until the south rise of the Bear-creek synclinal is reached, where they are supposed to leave the fault with a westerly strike. The exact line of this fault is not known on the No. 3 area of the Acadia Coal Company, which lies to the south of the Fraser area, but it is believed to continue in the general course of S. 22° E., which it is known to have near the Stellar mine.

On the No. 3 area the black shales overlying the Main seam have been proved by a few trial-pits, but no coal seam has been found between the McCulloch-brook fault and the stream itself on the south rise of the Bear-creek synclinal. On this brook, on the Culton area of Messrs. Sinclair and Haliburton, about six chains south of the north line of the area, an opening has been made upon a coal seam locally known as the Culton seam. Here the dip is N. 15° W. < 15°, which is about the direction of the adit or slope upon the seam, which, according to Mr. Joseph Richardson, who was in charge of the prospecting here, was but two inches in thickness at the out-crop, increasing in forty-five feet to three and a-half feet of very good coal. To the dip of this slope, in a position not now accurately known, a bore was put down upon this seam, which Mr. Haliburton informs me proved its thickness to be six feet, the coal being of very good quality. This seam at the Culton adit, as the slope was called, was directly overlaid by a thin band of highly carbonaceous black shale, known as *oil bat* by the miners, and then by a band, about six inches in thickness, of black carbonaceous shale, full of *Spirorbis* and *Cythere* shells. In the remains from the slope numerous fossils were found, among which may be mentioned well preserved teeth, spines and scales of *Diplodus*, with *Cordaites borassifolia* and impressions of *Lepidodendron*, *Antholites* and *Cardiocarpus*, not specifically determined.

Culton seam.

Six feet thick.

Fossils.

A large number of pits and bore-holes have been sunk in the great mass of black carbonaceous and argillaceous shales which overlie this seam by Messrs. Sinclair and Haliburton and the Intercolonial Coal Company, but no seam of coal has been found. This, together with the fact that it is shewn by the general structure to be in all probability the Acadia seam presently to be described, which again I believe to represent the Main, leads me to the supposition that the Culton seam is the representative of the Main seam of the Albion mines, its small size being partly due to the presence of a fault known to exist in the Culton adit, though there may also be a thinning of the seam in this direction.

Equivalence of Culton seam.

One underlying seam is said to have been proved, but of its size, char-

acter or position no record has been kept, though I am informed by a workman employed in sinking the bore in which it was found that twelve feet of coal were passed through. Still lower seams may crop out in the interval between this bed and the South fault, but no exposures of coal are seen, and the drift being exceptionally deep (its thickness occasionally reaching from eighty to 120 feet) but few attempts have been made to find them, such trials as have been made always resulting in failure. Twelve feet seam.

The Culton seam is traced but a few yards to the westward of the Culton adit, but the general structure would lead us to expect that at about thirty-four chains N. 72° W. its crop would come against the West fault; in this position a pit was sunk by Messrs. Bürkner and Ellershausen, when prospecting in this region, and two feet of a seam were found in the vertical measures of a dislocation which was undoubtedly the West fault. West fault.

In passing round the west end of the Bear-creek synclinal the out-crops of these seams do not leave the West fault until, at about thirty-six chains in the bearing N. 33° W. from Messrs. Bürkner and Ellershausen's pit, a large seam of coal is found in trial-pits sunk by Mr. W. Barnes for the Intercolonial Coal Company, which is known locally as the Acadia seam, and which is in all probability the representative of that of the Culton adit. The out-crop of this seam leaves the West fault with a general dip of S. 80° E. about 400 yards south of the slopes at the Drummond colliery, and curves gradually north and to the west of north on the anticlinal between the Bear-creek and Albion troughs, till the southern line of the Acadia Company's Carmichael area is reached. Thus far its crop has been accurately ascertained by crop trial-pits and the underground workings from the Drummond colliery. At this colliery the dip is E. (or S. 67° E. Magnetic) <16° at the surface, the dip at the north line of the area being about N. E. and the strike N. 41° W. (N. 18° W., Magnetic) is preserved across the Carmichael (Acadia) area with great regularity as proved by the underground levels from the Acadia (west) colliery, where the dip is N. 49° E. <20° near the surface. Thence it is traced by pits to the Nova Scotia Coal Company's slope were the dip is N. 42° E <28°. Here the strike turns more to the west for eighteen chains, which is the distance that it has been accurately traced. A short distance farther this strike will intersect the West fault, and the seam will be again concealed. This seam of coal is about eighteen feet in thickness at the Intercolonial, Acadia and Nova Scotia collieries.* Drummond colliery. Acadia colliery. Nova Scotia colliery.

As has already been stated it would seem most probable that this seam is the representative of the Main seam of the Albion mines, somewhat reduced in thickness and changed in character, but still furnishing an Seam equivalent to Main seam.

* Sections of this seam at different points will be found included in the descriptions of the collieries.

excellent quality of coal. Opinions have differed very much as to which of the lower seams it should be identified with, many miners advocating identification with the Deep or the McGregor seam. Many reasons exist for supposing it to be the Main, and I consider that the following facts will remove all doubts on this subject:

Barren measures over Acadia seam.

By reference to Section 4 it will be seen that the greatest mass of barren measures between the Main and McGregor seams consists of the strata between the Main and Deep seams, amounting to rather more than 148 feet, while above the Main seam barren measures exist amounting to over 1100 feet. Numerous trial-pits have been sunk on the measures overlying the Acadia seam, in which no trace of coal has been found to my knowledge, and a bore-hole has been sunk to the Acadia seam about fifteen chains from the Drummond colliery in a bearing S. 67° E. by Mr. Barnes, which, according to his record, proved barren black shale directly overlying the seam to a thickness of about 170 feet at right angles to the plane of the strata. These shales as seen in the Drummond colliery air-pit are remarkably like the black carbonaceous shale from the Foord pit at the Albion mines. The six inches of shale immediately overlying the seam at the Drummond colliery contains, *Spirorbis* and *Cythere* shells, *Antholites*, *Lepidodendron*, *Cordaites borassifolia*, and markings which I am informed by Dr. J. W. Dawson are *Lepidostrobus*.

Fossils.

Red Brook.

At the Acadia colliery no records exist for an accurate section of the strata. A short section as furnished by the record of the air-pit is given in the description of the colliery, and above this the measures obtained in the railway cuttings and in a number of pits sunk on Red Brook running north-east from the colliery appear to consist of black argillaceous shales, with some thin bands of bluish-grey argillaceous and white arenaceous shales having black carbonaceous partings, the white shales being in beds of from one twentieth to one fortieth of an inch in thickness. Farther west the measures directly overlying the Nova Scotia Coal Company's slope appear to be very thin bedded black arenaceous shales, with bands of carbonaceous and argillaceous black shale.

Seam equivalent to Deep seam.

A second seam has been found underlying the Acadia seam at about 160 feet, which probably represents the Deep seam of the Albion mines; also a third which I believe to represent the Third seam of the Albion group. A fourth is reported, but of this no record can be obtained.

The crops of the Second and Third seams run nearly parallel with that of the Acadia seam. The Second has been proved on the areas of the three companies working the Acadia seam, and is said to be about twelve feet in thickness, of which eight feet are reported to be good coal. The coal from this seam which I have examined, however, is coarse and shaly with about 30 per cent. of ash; but the specimens not having been taken from the

seam by myself, I cannot state that they fairly represent the entire bench of eight feet. The crop of the Third seam, being quite near the West fault, will probably be confined to a short run on the Intercolonial and Acadia (Carmichael) areas.

West fault.

Continuing the course of the West fault north-westward we find no further appearances of the lower coal seams along the western boundary of the coal field, the structure indicating the deepening of the coal measure trough, and that the higher rocks are brought against the Millstone Grit series on the west side of the West fault until we approach the North fault. The position of the intersection of these dislocations is approximately shown on the map, but farther explorations may induce alterations.

North fault.

The boundary of the coal field now becomes the North fault; and tracing this east, we find the altered Devonian rocks brought against barren coal measures, probably representing the black shales, with no appearance of the lower seams until the Sutherland and the Montreal and Pictou areas are reached, when the outcrops of at least a portion of the lower group of coal seams leave the fault in a north and south transverse swell on the north rise of the Albion synclinal, the curve of these crops corresponding in some degree with the opposite curve in the crops of the Albion group of seams on the south rise of the trough.

Montreal and Pictou area.

Before reaching the East River the out-crops turn back towards the fault, and meeting it at nearly a right angle, are not again seen in the region examined. The small extent of surface over which these seams can be observed, the almost entire absence of exposures, and the change in the character of both seams and including measures, combined with the high angles of dip and sharp turns in the strata, as seen on the banks of the East River, render the identification of coal seams here with those of Section 4 at the Albion mines, a matter of extreme difficulty. The region for some distance from the great North fault is also much disturbed by minor dislocations, and none of the coal seams have been sufficiently opened to show their characters when in an undisturbed position.

Difficulties of comparison.

Evidences.

At present the only obtainable facts with regard to the seams at this point are in the records of the Montreal and Pictou Coal Company's trial and working-pits, a record of borings made for the Intercolonial Coal Company on the Sutherland area, and such verbal information as Mr. Haliburton, managing director of the Montreal and Pictou Company, has been able to give me concerning the underground work done by that company. The exposures on the banks of the East River give the structure of the eastern side of the tranverse elevation; the Montreal and Pictou pit gives the south side and turn of the strata to a strike a little south of west; but for the western dip, we have only the records of two trial-pits, and such facts as the topography and surface rocks can furnish.

It has been supposed that the seam proved in the working-pit of the Montreal and Pictou Company represents the Main seam of the Albion mines; but the fact that coal crops are connected with measures manifestly overlying this seam a few hundred feet, together with the fact that the seam appears to be within 225 feet of another proved on the old road to Fraser Ogg's quarry, which for reasons to be given hereafter, I am inclined to believe represents the Stellar seam of the Acadia mines (Fraser area), leads me to identify the Montreal and Pictou seam with the McGregor, rather than with the Main or Deep seam, the equivalents of which, in absence of evidence to the contrary, I am inclined to think will be found to overlie it. The following facts may lead to the finding of one or both of these overlying seams. I would first remark, however, that in a region so likely to be broken by faults, mistakes in distances between seams are to be guarded against, as different exposures of the same seam, when it is thrown by faults, may be mistaken for different seams.

Seam equivalent to McGregor seam.

(1). On the south-eastern portion of the Intercolonial Coal Company's Sutherland area, a bore-hole was sunk which passed vertically through twenty feet of coal divided into two parts by four and a-half feet of fireclay. The inclination of the strata is not stated, but it is supposed to be about 65°, which would give a thickness of about nine feet to the coal and a foot and a-half to the parting. The position of this would appear to place the seam higher stratigraphically than that of the Montreal and Pictou pit.

Nine-feet coal seam.

(2). On the west bank of the East River, near its intersection with the north line of the General Mining Association's area, there is a mass of coaly shale of considerable thickness, mixed with a black shale so highly carbonaceous as to yield a large amount of gas. It is supported by a *Stigmaria* underclay, beneath which occurs the crop of what appears to be a true coal seam. This, it appears to me, may possibly represent the Main seam.

Seam equivalent to Main seam.

(3). On the same bank of the river, opposite the town of New Glasgow, a pit was sunk on a coal seam stated to be seven feet thick; this, it is said, was lost upon a fault, and as no record of the work was kept, its exact position cannot be given. At the time this was opened it was supposed to represent the Montreal and Pictou seam, but from the structure, which is well shewn on the river bank, I am inclined to think it belongs to measures several hundred feet higher.

Seven-feet seam

Provisionally considering the Montreal and Pictou seam as the McGregor, it would seem probable that the crops of the Albion group leave the North fault, with westerly dips at a moderately high angle, at some distance west of the east line of the Sutherland area, and the seam provisionally considered to be the Oil coal will be not far from this line at the fault.

Albion group of seams, in relation to the North fault.

This westerly dip is preserved by the upper portion of these seams till they approach the Montreal and Pictou corner on the General Mining

Association's north line, near which a pit (No. 2 of the Intercolonial Company's Sutherland area record) has proved the dip to be S. 67° W. (or W. magnetic) in bearing, with an inclination of about 65°. The Montreal and Pictou seam at the working pit, dips S. 43° E. (or S. 20° E. mag.) < 65° ; there must therefore be a very abrupt turn or a dislocation between the two pits. At the working pit the seam thus shows a turn toward the northeast, and thence the structure can be given with comparative accuracy from the river exposures. These show the run of the measures to be nearly parallel with the bank of the stream, trending somewhat to the east of north until opposite the town of New Glasgow, where they all come against the North fault again, with a strike probably at about right angles to its course.

In a region so likely to be disturbed by the forces which have produced a dislocation of such great extent as the North fault, records of scattered pits are always unsatisfactory, as the dip in any of these pits may be influenced by a fault, or by a sudden twist in the strata, even if a break has not occurred. The structure of this immediate part of the coal field, as indicated on the map, must therefore be understood as merely general and illustrative, and liable to considerable alteration in detail from future explorations. Provisional structure.

The presence of the great seams of the Albion group has prevented any attempts at systematic explorations for coal beds above the barren black shales on the west side of the river. A few trial-pits, however, exist in the upper portion of these measures, but of these there is in most cases no record, and the only indications of coal there at present known are believed to belong to a bed which occurs between the black shales overlying the Main seam of Section 4, and certain black shales of Potter's Brook on the east side of the East River ; the only evidences of this seam are in the pits mentioned, and a few exposures far apart from one another. This I have called the Three and a-half feet seam. Few researches for coal above the black shales. Three and a half feet seam.

The seam is first seen in a cutting on the Nova Scotia Railway, about two chains north of the culvert over Coal Brook in the vertical measures of a fault ; but it is here on the south rise of the Albion synclinal, and its crop is known westward about one mile by two pits, one sunk on the side of the New Glasgow and Hopewell road, near the crossing of Coal Brook, and the other on a small branch of the same brook, about one half mile west. Thence the general structure would indicate that its course would be somewhat as shown on the accompanying map, where it is represented that at the McCulloch-brook fault the crop is thrown about seventy chains south. This seam does not appear in the Bear-creek synclinal, the deepest point in this trough showing only about 800 or 900 feet from the surface to the Acadia (Main) seam. West from the McCulloch-brook fault the Distribution. McCulloch-brook fault.

crop turns north-west on the south rise of the Albion synclinal, crossing the old post road to Middle River a short distance west of the Intercolonial Coal Company's railway. Thence it is not known except by a crop on the post road to Truro, near the turning to the private road running south to the Horn farm. This point is shown by the structure of the measures below the seam to be nearly on the axis of the Albion synclinal, and the seam probably crosses the road nearly at right angles to its general course.

Axis of Albion synclinal.

Beyond this exposure the course of the crop cannot be followed with accuracy back to the McCulloch-brook fault, and as laid down on the map it must be taken as conjectural, and as merely illustrative of the general structure. The only coal crop known on the north rise of the Albion synclinal between the West and McCulloch-brook faults was met with in laying the foundations for the Intercolonial Coal Company's railway bridge over McCulloch's Brook. This is stated to have a thickness of three feet, and it is probably the seam in question, though it is here carried eastward, and nearer to the centre of the synclinal than might have been expected, by the effect of an east and west fault presently to be described, throwing up the measures on the north side. From this position at the railway bridge the general structure would bring the crop to the McCulloch-brook fault, but this being an upthrow on the east side, the plane of the seam is carried by it above the general level of the surface, and the crop does not again appear on the north side of the east and west fault, unless it be represented on the north branch of Coal Brook, which is a considerable distance to the east, by a coal crop a few feet on the north side of the disturbance above alluded to, which it leaves for a few chains, returning to it again.

Coal crop on McCulloch's Brook.

An E. and W. fault.

Farther eastward the north rise of this seam appears to leave the south side of the fault, and on approaching the Albion mines there are indications of its crop on the north side of the Hopewell road about two chains north of the railway bridge near Coal Brook; this, and a similar exposure on the East River at the mouth of the brook, seems to show the general course of the Three and a-half feet seam as far eastward as it is at present known. No other coal seam overlying the black shales has been observed to the west of the East River.

Coal crop near Coal Brook.

All the greater faults limiting or considerably effecting the distribution of the coal seams, have already been alluded to. Those affecting the underground workings in the different collieries will be mentioned farther on in the detailed descriptions of these workings; but besides these many dislocations of greater or less extent traverse the Productive coal measures, though the greater number of them are of slight importance. These may be divided into three series, those belonging to each preserving a general parallelism in their bearings,

Systems of faults.

though a few exceptions are known. They are (A) faults having a general course of N. 33° W. and S. 33° E.; (B) faults having a general bearing E. and W.; and (C) faults having a direction of about N. 67° E. and S. 67° W.; besides these a fourth series (D) may be added having a course of N. 58° W. and S. 58° E., of which several examples have been known, as will be especially seen in the workings of the Deep seam at the Albion mines.

Of these minor dislocations two have been observed affecting the measures near the centre of the Albion synclinal, of which descriptions may be introduced here. The first, which may be called the Potter's-brook fault, was first noticed on that brook near its junction with the East River. It is a downthrow to the south, apparently of considerable extent, and has an E. and W. direction, the exact bearing from Potter's Brook westward being N. 86° W. It has been traced westward from the East River about a mile and three quarters, and is the same break as has already been mentioned in connection with the Three-and-a-half feet coal seam. My belief is that it will extend across the McCulloch-brook fault, by which it would seem to be broken and thrown southward, and thence will be found to run across the western portion of the coal field to a point near the intersection of the North and West faults. This supposition has been induced by the fact already stated, that a fault with a southern downthrow seems to affect the crop of the Three-and-a-half feet seam between the Truro post road and the railway bridge on McCulloch's Brook. The Potter's-brook disturbance would thus belong to a more ancient system of faults than that deriving its name from McCulloch's Brook.

Potter's-brook fault.

Broken by the McCulloch-brook fault.

The effect of the second of these dislocations is seen at the railway iron bridge over the East River, just above the town of New Glasgow, where the measures, which, on the right bank of the river above the bridge, are seen with dips somewhat to the south of east at moderate angles, on approaching the fault are suddenly thrown round to a dip of north at a high angle. This turn to the north at this point is probably in part due to an undulation corresponding to a third or subordinate synclinal, which you have observed on the east side of the river, and which, I believe, you have named the North synclinal. But the immediate cause of the sudden turn and high angle of dip in the strata appears to be due to the fault, which has a bearing N. 67° E. at the lower end of the bridge.

Bridge fault.

ECONOMIC CONSIDERATIONS.

In the treatment of this coal field with reference to its economic importance, it would seem best to divide it up into the different mining areas as surveyed and leased by the Mines Department of the Province, giving

Economics.

under the heading of each area, descriptions of such collieries as are now in active operation, of workings which have been abandoned, and of railways built and owned by the various coal companies.

Extension of map.

It has therefore been thought proper to extend the map designed to illustrate the region, beyond the area examined, in order to show the connection of the Productive coal field with tide water at Pictou and Merigomish harbours; and with a view of properly filling the topography, a number of roads near the town of Pictou, and a plan of that town, have been taken from a map of the county of Pictou published by Messrs. A. F. Church and Co. of Halifax.

The southern limit of the map will be the parallel 45°.30′ of north latitude, while northward it will extend as far as the entrance of Pictou harbour on the Gulf of St. Lawrence; east and west it will reach so far as to include the harbour of Merigomish and the valley of the West River.

The projection of the map is based upon Admiral Bayfield's determination of the geographical position of Pictou light-house at the entrance of Pictou Harbour,* and Betty Point, Merigomish Harbour †.

GENERAL MINING ASSOCIATION.

General Mining Association.

The history of the acquisition by the General Mining Association of the Royal patent granted to the late Duke of York, giving them possession of all the minerals of the Province of Nova Scotia; of their extended working and exploration in Pictou and Cumberland counties and the island of Cape Breton, and of their final cession of the greater portion of their rights in consideration of certain facilities and franchises granted them by the Provincial Government, is too well known to need rehearsal.

ALBION MINES AREA.

Albion mines area.

By reference to the map it will be seen that the area of three square miles, selected by this association in the coal field, is the central one of the areas embracing the Productive coal measures. It includes the crops of the two principal seams, the Main and the Deep, both of which have long been worked by the company. Till within a limited period the Albion mines, and some workings on the McGregor seam on what is now called the Fraser area of the Acadia Coal Company, constituted the only regular workings of the Pictou coal field, and upon the coal shipped by this company was established, in the first instance, the reputation of Pictou coal.

Importance of the workings.

These workings have now reached a great importance, not only from their considerable extent, but from the number of collieries in active opera-

* Pictou light is in 45° 41′ 25″ north lat., and 62° 39′ 19″ west long.

† Betty Point is in 45° 38′ 29″ north lat., and 62° 26′ 40″ west long.

tion, and from an actual power of production exceeded by very few on this continent. Although these collieries are included under the general term of the Albion mines, it will be necessary to describe them under the following local names, indicating either districts with well marked boundaries or separate working pits: 1, Burnt mines; 2, Crushed mines (abandoned); 3, Dalhousie pit works; 4, Forster pit works; 5, Foord pit works, all on the Main seam; and 6, Cage-pit works on the Deep or Cage-pit seam.

Burnt mines.

Burnt mines.—The Burnt mines include the earliest workings from the crop of the Main seam, and extend from the west bank of East River about one-half mile northwest toward the Dalhousie pits. Though these workings have long been abandoned in consequence of a fire, I am informed that the pillars have not been crushed, and might still be taken out, should the course of trade require it.

Crushed mines.

Crushed mines.—The Crushed mines are situated to the deep of those just described, their extent being from the east bank of the East River northwest to the Dalhousie pits, a powerful barrier of coal being left between them and the Burnt mines.

Dalhousie pit works.

Dalhousie pit works.—The Dalhousie pit works are at present in actual operation and capable of producing about 800 tons of coal per diem. The machinery at the Dalhousie Bye pit, or drawing pit, consists of one 50 horse-power beam engine, single cylinder, drawing cages containing one box or car holding 1500 lbs. of round coal, by a 4-inch flat wire rope.

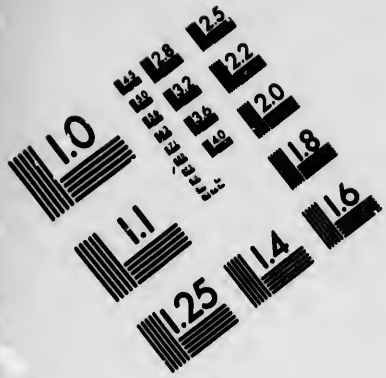
The arrangements at bank, shutes and railway near the pit head are of a very complete, substantial and convenient description, and the celerity of hoisting, dumping and screening the coal at the pit head evinces a system and management worthy of imitation elsewhere. This pit has been extensively worked during the past summer, the coal raised being taken principally from the pillars.

Forster pit works.

Forster pit works.—The Forster pit is a late working of this company, and during last season was only irregularly in operation. When in full operation it will be capable of producing from about 500 to 700 tons of coal per diem. The arrangements at the pit head and elsewhere are much the same as those at the Dalhousie pits. The workings of the Forster pit, Dalhousie pit and Crushed mines are pumped from the Engine and Staple pits at the Crushed mines, communication being made for this purpose. The water is lifted by a large double-acting Cornish pumping engine of about 100 horse-power driving the top lift of the pumps in the Staple pit, and the bottom lift in the main or Engine pit, the lifts being about 250 feet each.

Foord pit works.

Foord pit works.—The Foord pit works, when in full operation, will be of so great importance to the coal field that I may be excused for giving the full description which follows of the pits and machinery in so far as



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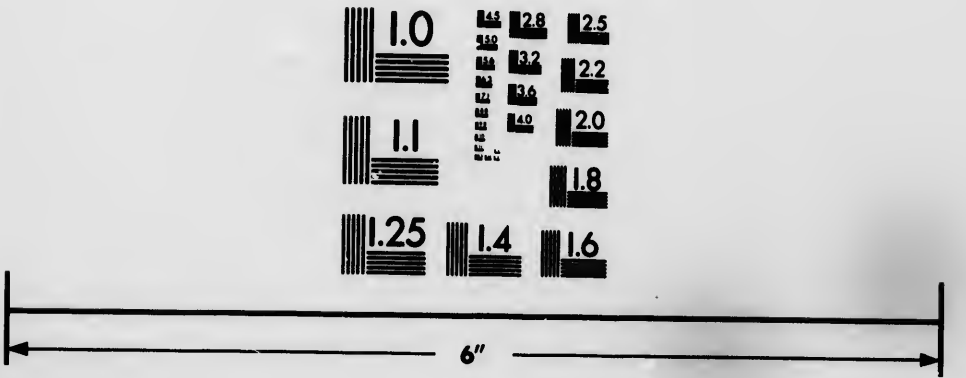

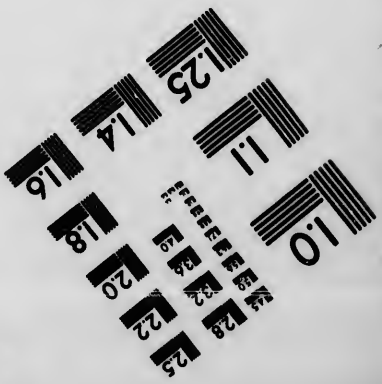

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complete at the time of my return from field work. In size and in the perfection of design in the machinery, and in fact of the entire plant, these works will compare most favourably with any on this Continent, and may be considered an important addition to the wealth of the Dominion.

Two principal pits.

Two principal pits, known respectively as the Foord drawing and pumping pits, have been sunk to the Main seam at a horizontal distance of 960 yards from the crop, reaching a depth of 878 feet; and a third to a depth of 330 feet for the first or top lift of the pumps, the drawing pit being about 40 yards to the deep of the other two.

Drawing engines.

The drawing engines are two high-pressure horizontal cylinders 36 inches in diameter and 5 feet stroke, or as connected, of about 160 nominal English horse-power. The crank-shaft connecting these engines is 15 inches in diameter and carries a 20-feet drum, included between two 22 feet fly-wheels, which are fitted with powerful friction brakes, by means of which the engines can be stopped almost instantly, should circumstances require. The engines are fitted with slide-valves, moving on anti-friction rollers, and the arrangement of weigh-bars for the throttle, links and brakes is such that one engineer has them under perfect control. The cages in the pits are made of bar steel, weigh about 900 lbs. apiece, and are double decked, carrying four cars or boxes holding 1500 lbs. round coal each. With the moderate piston speed of 250 feet per minute, and allowing full time for all ordinary delays and stoppages, these engines ought easily to deliver 1000 tons of coal on the platform, per day of ten hours, which, with coal from the banks, would make the ordinary production in full operation about 1500 or 1600 tons of coal per diem.

Engine house.

The engine house (61 by 35 feet) and all fittings in the pits and around the pit head are of the most substantial character, the engine house being of cut stone and brick, the foundations of cut stone and concrete, the pillars for the platform of brick, and the timber work of frames, platform and pit-timbering, of the best southern pine, a ship load of which was especially selected for these works.

Pumping engine.

The pumping engine is a single cylinder, high-pressure Cornish engine, the cylinder being 62 inches in diameter and of 9 feet stroke, or 240 nominal English horse-power. This engine is set upon a massive column of cut stone, resting on the solid rock below. The height of this pillar is as follows:—From the foundation (at the surface of the ground) to the top of cylinder pillar 21 feet 6½ inches; thence to the top of the beam pillar 22 feet; and from the top of the beam pillar to the centre of the bearings 4 feet 6 inches; or about 50 feet from the surface of the ground to the bearings.

The cylinder is set over the top-lift pit, the piston-rod, 8 inches in diameter, coming through the cylinder bottom, driving the top set of pumps

direct, as in the Bull engine, the second and third sets being driven through the beam, which is of wrought iron plates riveted to iron castings. This beam is 34 feet long, 7 feet deep in the middle and 2 feet 4 inches at the ends, its weight being 18 tons, without gudgeons, these being of wrought iron 14 inches in diameter for the central one at the bearings, increasing to 16 inches in the middle, the end gudgeons being 8 inches in diameter, increasing to 9½ inches in the middle, and the intermediate for parallel motion rods being 4½ inches in diameter.

The pumps, etc., are of the following patterns and sizes: Pumps.

First or top set lifting pumps, working-barrel, 18 inches diameter.
Second or middle forcing pumps, working-barrel, 18 inches diameter.
Third or bottom set lifting pumps, working-barrel, 18 inches diameter.
Column pipe, inside diameter, 19 inches.

Both drawing and pumping engines are supplied with steam by a suite of six cylindrical boilers, high pressure, 5½ feet in diameter and 35 feet long, fed with water by two donkey engines and pumps of 7-inch steam cylinder, and fitted with the latest appliances for convenience and safety. Flues, furnaces and stacks, are substantially built and lined with fire-brick. Boilers.

The General Mining Association own a fine railway, six miles long, from the Crushed mines to the loading ground, with branch lines, sidings and passings amounting probably to four miles additional. The loading wharf is situated on Pictou Harbour, at the mouth of the East River, and extends 400 yards from the shore to 22 feet of water. Railway. Wharf.

Vessels of greater draught than 20 feet are generally loaded with coal from lighters owned by the Company, who also keep a powerful tug in the harbour for the convenience of vessels consigned to them. The arrangements at the wharf and the amount of rolling-stock, including five locomotives, appear to be ample for a shipment of about 3000 tons per diem. The largest amount thus far regularly shipped was during the summer of 1867, when shipments averaged for some weeks 2,400 tons per diem.

The locomotive, car, and blacksmiths' shops are well stocked and arranged, and at the machine shop and foundry all small machinery, and even some slope engines of considerable size, (24 inch cylinder), and of very creditable workmanship have been manufactured. In addition to the works described, the Association have built a large number of houses for overmen, workmen and others, and have a full complement of repair and carpenters' shops, barns and other buildings, all upon the property area of the company. Work shops.

UNDER-GROUND WORKINGS MAIN SEAM.

The first pits at the Albion mines known as the Stair, Store, Engine and Bye pits, gave access to the workings of the Burnt mines, which extended Burnt-mines pits.

on the lower level about 250 yards southeast, and 900 yards northwest toward the Dalhousie pits, the deepest pit being the Engine or drawing pit, 199 feet to the bottom of the Main seam. These pits are now entirely crushed in and filled with *débris*. Separated from these workings by a barrier of about thirty yards of coal are the Crushed mines, which were worked from the following pits:

Crushed-mines pits.

Engine pit for pumping	451 ft.	6 in.	to Main seam.		
Bye or No. 1 pit for drawing	436 "	6 "	"	"	"
No. 2 pit	392 "	0 "	"	"	"
No. 3 pit	332 "	0 "	"	"	"
No. 4 pit	284 "	0 "	"	"	"
Up-cast pit	248 "	0 "	"	"	"

Pits Nos. 1, 2, 3 and 4 correspond to the four railway bords or main levels, in former times a pit being sunk for every six working bords.

The lowest level of the Crushed mines extends about 1000 yards southeast from the Bye pit, or about 180 yards beyond the meeting of the three roads near the Big branch bridge, East River; and from this level at 600 yards from the pit a slope was sunk, running eastward at *half across dip*, or at an angle of 10°, and from this slope, workings were in successful operation until the fire occurred which caused the Crushed mines to be abandoned. Westwardly the lower level extends about 1200 yards to the barrier of the Dalhousie pit workings, and at about 100 yards from the pit a slope has been driven about N. 48° W. 700 yards.

Foord pits.

Fears have been entertained by the workmen employed in the Foord pits that danger might exist of *holing into* these old workings now full of water; but according to careful plans, as kept in the office, no point of these deep workings approaches nearer than about 400 yards, or nearly a quarter of a mile, to the Foord pits.

Dalhousie pits.

The Dalhousie pits are four in number: 1, Dalhousie Bye pit 250 feet deep; 2, Engine pit of the same depth; 3, Top pit 130 feet deep to the Main seam; and Dalhousie Down-cast pit 440 feet deep through the Main to the Deep seam.

Dalhousie section of Main seam.

The section of the Main seam at the Dalhousie pits is as follows, reduced from the records of the Engine pit:

	Ft.	In.
Coarse coal	0	2
Good coal	4	8
Iron stone	0	6
Good coal	13	3
Iron stone	0	4
Coarse coal, of good quality	7	0
Iron stone	0	4
Coarse coal	2	9
Iron stone	0	4

	Ft.	In.
Coarse coal	2	7
Iron stone	0	5
Coarse coal	4	5
	36	9

To the east of the Dalhousie pits the upper twelve or fourteen feet only of the seam was worked, the bottom coal not being considered marketable. To the north-west, however, the whole seam is worked in the Dalhousie workings, giving some twenty-eight feet of excellent coal, the bottom being coarser merely in appearance. The six-inch parting of ironstone increases going west and encroaches on the *fall coal*, which is not worked at the Forster pit. Farther west, at the western face of the Forster pit workings, the whole seam appears to deteriorate somewhat, the coal becoming of a dull lustre and shaly texture, and several of the partings increasing in thickness. About twenty-two feet of the lower part of the seam is there worked.

Lower levels.

The lower levels of the Dalhousie pit extend 1,100 yards north-west to the Forster pit, dip workings having also been extensively wrought from a slope, the head of which is near the Dalhousie Engine pit, through which steam is supplied to the slope engines. These engines, and also those of the two Crushed mines slopes, are horizontal drawing engines, with connected 24-inch cylinders and 48-inch stroke. They hoisted coal trains of twelve boxes each. The bearings and distances to which this slope was driven are N. 48° W. 920 yards, then, the dip increasing, N. 66° W. 160 yards farther.

Forster pit.

From the Forster pit the lower railway bord or main level has been carried 480 yards west, giving an entire length of working of 3,600 yards from the eastern face of the Crushed mines. On account of the deterioration of the seam going west very little coal has yet been taken from the western workings of the lower levels; a slope 150 yards to the dip and a travelling way driven to the crop constitute their extent.

Explosion Foord pit.

The Foord pit workings under ground consist of the three pits already described and a small amount of narrow work, the levels extending at present about 100 yards north-east and south-west from the pit bottom. The progress of the workings has lately been delayed by an explosion of gas, which, but for previous precautions and promptness of action, might have proved disastrous. Fortunately however, the men were got out without injury, the loss being that of the horses under ground and the burning of a portion of the timbering and guides of pits. The damage having now been repaired, work will be resumed at once. At the time the explosion occurred (March 27th, 1869) eighty four men were employed under ground.

Under-ground workings Deep seam.

Deep seam.

The Deep seam workings are reached by Cage (drawing) and Success (pumping) pits. The capacity of these works is similar to that of the Dalhousie pits, and the over-ground works are of the same design and extent, with the exception of the pumping machinery, consisting of a large horizontal engine driving two lifting pumps.

Cage pit.

Levels have been driven about 2,300 yards west of the Cage pit, and for about one mile of this distance the coal above the bottom level, about 250 yards from the crop, is standing in pillars, with the exception of a portion 1500 yards from the pit, where pillar working has been commenced. Eastwardly from the pit the workings have been carried only about 170 yards, where gas becomes so troublesome that work was stopped.

Deep seam section.

The section of the Deep seam, near the eastern face, is nearly as follows:—

		Ft.	In.
Dark brown carbonaceous fireclay		4	0
Dark brown carbonaceous shale	worked	0	6
Good coal		2	9
Coarse coal		0	9
Good coal		2	9
Coarse coal		1	4
Good coal		5	0
Shale or shaly coal, not exposed		3	0
		20	1

Cage pit section.

Going westward the character of the coal materially improves. At three quarters of a mile from the Cage pit the section is:

	Ft.	In.
Good coal	6	6
Very coarse coal holding much iron pyrites, called stone parting	1	6
Good coal	11	9
	19	9

Here the seam is at its best, and was all worked, yielding, with the exception of the coarse coal parting, most excellent coal. From the fourth counterbalance to the western face, the bottom bench, ten feet of good coal is worked; the upper portion of the seam has not been proved lately.

Systems of working at the Albion mines.

System of working.

With slight modifications *the post and stall*, or *pillar and bord* system of working has been used in the Albion mines since the first openings were made. The practice of this system involves long bords, or working places, and gate roads or inclines, running diagonally across the bords to the main level, at such an angle to the full dip, that the coal can be easily taken to

Pillar and bord.

the railway bord by sleds drawn upon the floor of the seam; by cars running on railway tracks, drawn up to the bords by horses, and withheld from too great a velocity in descending by a drag chain running around a stout post at the head of the incline; or by cars running on a three-rail track, with passings, a drum with a friction brake being so arranged at the head of the incline that the loaded cars in descending draw up the empty ones. The bords are in most cases about 6 yards wide, the pillars from 8 to 12 yards.

Back-balance.

During the past two years the new back-balance or self-acting counterbalance system has been introduced at these mines, and is now in successful operation in the Cage-pit workings. This was first used in Lancashire, England, and was introduced into this province by Mr. Hudson of the General Mining Association.

In this system an incline about 10 feet wide is started from the main level, and driven direct to the rise, either to the next level, or above the upper level, as far as it is intended to work the coal. Two tracks are laid in the back-balance, extending from the the main level to within about 20 feet of the top of the incline, where a drum fitted with a friction-brake is firmly set. Upon one of the tracks (say the left for illustration) runs a car or box so loaded with stone as to rather more than counterbalance the weight of a cage running on the right track when loaded with the weight of an empty car (supposing them to be connected by a wire rope or chain, passing round the drum at the head of the incline) while the weight of a full car on the cage will cause it to descend, raising the weight of the car loaded with stone.

In getting the coal a barrier is left for the main level, and then the first working bord is turned from the back-balance (to the right) and continued on the strike toward the next counterbalance, a distance varying from 150 to 200 yards. Farther to the rise working bords are turned off at regular intervals, the system in the Cage-pit working being, main barrier 21 feet, bords 18 feet, pillars 18 feet. The platform of the back-balance cage runs down to a level with the floor of the main level, and a section of track is laid upon it (as in a pit cage) which is continous (when the cage is in position), with the rise track of the level. An empty car now being run on to this cage, and the brake of the drum being slackened, it is evident that the car will be drawn up the incline by the counterbalance weight, and that it can be stopped by the brake opposite to any of the bords where it may be required.

A temporary track being kept to the working face of all the bords, the car is run into the bord, filled, and again run into the cage, when its increased weight causes it to descend, the speed being regulated by the brake. On its arrival at the main level, it is pushed from the cage by an empty car, which

Economy of the system.

in its turn goes through the same process. As an example of the expedition and economy of this system, I may mention that one boy, at $0.60, can at the Albion mines brake down from 275 to 300 boxes of coal, holding 1500 lbs. of coal each, per day of ten hours.

Fire damp.

In the working of both the Main and Deep seams fire-damp or light carburetted hydrogen gas is sometimes given off the coal, in quantities which not only prove troublesome in requiring safety-lamps and other precautions, but also sometimes cause explosions disastrous to life and property, in spite of all precautionary measures. Several serious explosions have occurred in the older workings, in which not only have men been seriously injured, but the coal in the seams has been ignited, threatening the entire workings with destruction. In fact, so alarming did one fire from this cause become that it was deemed necessary to turn the water from the East River into the workings (the present Crushed mines) as the only possible means of extinguishing the flames. The greatest care is taken to prevent these disasters, to which all the mines of this region are liable, stringent rules being provided with regard to the use of the lamps; and by order of the Inspector of Mines, danger signals are posted, beyond which open lamps cannot be taken.

Precautions at the Albion mines.

At the Albion mines the greatest precaution is observed; barrels of water being kept in every working bord, and several small cannon are kept constantly loaded when gas is feared, to extinguish it if possible by concussion of the air. With all this care a blower of gas will sometimes ignite, generally from a blast, and become troublesome. Into the crack from which one of these blowers appeared, an inch copper tube was driven, and the gas ignited, when a flame was produced two feet long, which burnt continuously for six weeks. Against these explosions the only safeguards appear to be the most perfect ventilation, and cutting instead of blasting the coal.

Difficulties of working great seams.

The working of seams of coal of the size of the Main and Deep is at best a very difficult problem, requiring great care and experience. The explosions, fires and inundations to which the greater portion of the Crushed-mines workings have been subjected have proved the immediate causes of the *crushes* extending over these workings, and also over a portion of the workings of the Dalhousie pits, resulting in the loss of several of the Crushed-mines pits, and a large amount of pillar coal. The original cause of these crushes, however, has been from an inadequate scale of pillarage, the large size and considerable angle of the seams requiring pillars of an extent proportionally much greater than those required in most of the English coal fields, where, as a rule, the seams are of moderate size and the angle of dip quite low.

Inadequate pillarage.

Faults.

Very few faults have been struck in the workings of the Albion mines. Three were met in the Crushed mines dip-workings of the east slope. The

first has a course of N. 21° W, being a downthrow east of 40 feet at the dip slopes and running out to 3 feet at the lower level of Engine pit. The second is still farther, being at the end of the slope; its course is N. 10° W.; it is a downthrow eastward of 14 feet. The third is one connecting the first and second and not cutting the first; its course is S. 73° E.; it is a downthrow to the northeast of about 50 feet, where proved at about half distance between the first and second faults. Near these faults the gas was struck which caused the fire in the Crushed mines. Besides these three a few small faults are found in the workings of both seams, which appear to be arranged in two systems, the one running N. 33° W., the other S. 88° E., which, it will be observed, are the courses of several of the important dislocations affecting the general distribution in the coal field. Gas near faults.

The parallelism of the cleats or joints of the coal, and also of numerous small faults of a few inches throw, in the Deep seam, is quite noticeable though by no means exceptional. With very few exceptions their course is N. 58° W., while in the Main seam no marked parallelism is observed, some running N. 67° E., others S. 88° E., N. 33° W. and N. 58° W. Cleats.

ACADIA COAL COMPANY OF NEW YORK, U. S.

The Acadia Coal Company own three mining rights, which are as follows: Acadia Coal Company.

The Fraser area, south of the General Mining Association's area; the Carmichael area, southwest of the General Mining Association's area; and No. 3 area, lying to the south of the Fraser area.

FRASER AREA.

Workings have been carried on for many years upon the Fraser area; first by the General Mining Association, and more lately by Mr. J. D. B. Fraser, of Pictou, from whose possession it passed by lease to the present company. Fraser area.

Attempts have been made by former owners to work the Deep seam on the western portion of the area at the McKenzie pit, and a slope has also been driven some distance on the crop of the Third coal seam, both of which workings are now abandoned, and therefore require no special description. The present workings are confined to the McGregor seam and two openings on the Oil-coal. McKenzie pit. Deep and Third seams.

McGREGOR COLLIERY.

In the McGregor colliery the openings consist of No. 1, an adit, No 2, a slope, and No. 3 a pair of slopes. McGregor colliery.

Adit No. 1 was opened by the General Mining Association on the left bank of Coal Brook, near the crossing of the Middle River road, and driven No. 1 Adit.

N. W. a distance of about 800 yards. The seam was irregularly worked by the General Mining Association and Mr. Fraser, but is, I believe, for the present abandoned.

No. 2 slope. Slope No. 2 is a single slope to the lower level of No. 3 slopes, and was formerly the working slope, but is now used only as a travelling way. It stands on the left bank of Coal Brook near the mouth of No. 1.

No. 3 slopes. Slopes No. 3 are the principal working. Their situation is 170 yards S. E. of No. 2, on the right bank of the brook. Their total depth is 510 feet. Main levels extend 260 yards N. W. and but 20 yards in the contrary direction. The dimensions of the slopes are: Drawing slope (a double railway track) 9 feet post, 9 feet cap and 14 feet ground sill. The tracks are all of T iron 25 lbs. to the yard. The second slope, a travelling way for horses and men, is separated from the drawing slope by a 14 feet barrier of coal; its height is the same as that of the drawing slope, with 6 feet cap and 8 feet ground sill. A temporary engine is of 14 nominal English horse-power, with a horizontal single cylinder, driving the hoisting drum by shafting with clutch gearing; and also pumping through the Fleming pump pit by a wire rope running over sheave pullies to the pump bob.

In working the McGregor seam the upper coal (included in the upper six feet of the seam) is the only portion taken out, the lower bench being unsaleable. The seam is found to rapidly improve going west, as will be seen from the following sections:

Upper coal.

McGregor seam, upper coal.

	At No. 2 slope.	At western face.
	Ft. In.	*Ft. In.*
Good coal	1 9	2 9
Arenaceous fire-clay parting	1 0	0 6
Good coal	3 0	4 0
	5 9	7 3

Near the western face, the bord and pillar system with incline gate roads has been commenced. Elsewhere in the working the back-balance system is used.

Oil-coal workings.

Oil-coal. Two slopes have been sunk upon the Oil-coal seam, namely the Fraser mine on Coal Brook, near No. 3 slopes, and the Stellar mine on McCulloch's Brook. The principal value of this seam consists in the large quantity of oil contained in the bench mentioned as oil-coal in the general section, which in former years was extensively worked, the oil coal or *stellarite*, as it has been named by Professor Henry How, who first described it, selling for a high price for gas-making and distillation. The present low price of coal-oil from the extensive working of petroleum in this country and the United States, combined with the high tariff on imported

coal imposed by the United States, have combined to render the working of this seam unprofitable, and both workings are for the present abandoned.

As the quality of this peculiar coal will receive especial attention in the Appendix to this report, I will merely state in conclusion that from the large content of oil this seam must at some time prove of considerable value. From pits sunk by the Acadia Coal Company it would appear that the size and quality of the Oil-coal bench improves towards the east, the greatest thickness (1 foot 10 inches) being procured in a pit sunk at the corner of Grove street and Pennsylvania avenue in Acadia village, which coal produced 120 gallons of crude oil to the ton; the average obtained from the Fraser mine being about from 60 to 65 gallons per ton.

Carmichael area.

Carmichael area.

For many years no workable coal was known to exist to the west of the McCulloch-brook fault, on which the Albion coal seams are lost; and though many attempts were made to ascertain the position of these seams no coal was found until the 18th April, 1865, when Mr. Truman French, in prospecting for the Nova Scotia Coal Company, discovered the fine seam of coal now known as the Acadia seam, and presumed to be equivalent to the Main seam of the Albion mines. The first opening of this seam was on the area under consideration, near its western boundary, from which point it was traced north and south, as described in treating the general distribution of the coal seams.

Acadia seam.

Acadia colliery.

Acadia colliery.

The Acadia colliery, locally known as the Acadia west slope, is situated near the south-western corner of the Carmichael area, and within the village of Westville. Two slopes, corresponding in dimensions to the No. 3 McGregor slopes, have been sunk on the Acadia seam to a depth of about 140 yards from the crop.

Section of Acadia seam

The section of this seam and the strata immediately overlying, as measured in the air shaft of this colliery, is as follows:

		Ft.	In.	Ft.	In.
Brown carbonaceous shale				4	6
Black bituminous oil shale				0	7
Brown carbonaceous shale				6	6
		Ft.	In.		
Good coal, (1st bench)	Fall coal	2	9		
Good coal, (2nd bench)	Fall coal	3	6		
Light arenaceous fireclay or holing		0	3		
Good coal, (3rd bench)	Bench coal	3	8		
Coarse hard coal with iron pyrites, easily separated by dressing from the other coals	Bench coal	0	1		
Good coal, (4th bench)	Bench coal	3	3		
Coarse coal of fair quality	Bench coal	2	4		
Coarse coal not taken out	Bench coal	2	4		
				18	2
				29	9

Above the section given, no details for a column of strata can be procured, no record having been preserved of the numerous pits in the overlying measures. The remains from these pits, however, will enable me to state that at this colliery the seam is overlaid with a great mass of barren measures, consisting of black and brown carbonaceous and argillaceous shales, with occasional bands of dark arenaceous shale, and at least two thin bands of thinly laminated sandstones of a general white colour with black partings, as in the sandstones described in the Forster pit section. Under the seam there is a yellowish-drab *Stigmaria* underclay of at least four feet in thickness. The measures are then concealed for forty-two feet, at which point a heavy bedded sandstone appears, of a light brownish-drab colour, containing, where exposed in a quarry near the Acadia slope, large *Stigmaria* roots well preserved, as well as occasional stems of *Lepidodendron*.

Black shales

No faults.

At this colliery the seam has been proved to be without fault, by the main level, which now extends about 500 yards south and 400 yards north, the exact direction across the area being N. 41° W., (or N. 18° W. magnetic) corresponding to the dip of the seam, N. 49° E. (or N. 72° E. magnetic), which varies only in inclination, being 19° at the surface and about 23° at the lowest level. The under-ground workings are on the counterbalance system, and are remarkably regular and well laid out. Counterbalances are driven 15 feet wide and 100 yards apart, throughout the workings. An air course 8 feet wide is also driven up at 10 yards to the left of each counterbalance. Working bords are 15 feet in width, with 15 feet of pillar, 75 feet of barrier being left above the main level.

Counter-balance system.

MACHINERY.

Machinery.

The platforms at the head of the slope are roofed in. They extend from the mouth of the slope to the banks, and also to the shutes over the railway track. At this mine the fine slack is not sold, being carefully screened out, the rest of the coal being divided into two sizes, *round* and *chesnut*. The drawing engines were built in New York, and are fair specimens of the best type of American engines, being compact and easily handled, with none of the slightness of design usually observable in American machinery. They are horizontal high-pressure connected engines, 16 by 48 inch cylinders, working by a 24-inch pinion into a 16-feet spur-wheel on a 14-feet drum. The engine house is of brick and cut stone, with a corrugated iron roof. Pumping is effected by a small donkey engine, which is also arranged to hoist bank coal to the screening platform, the quantity of water in this mine being so insignificant that a two-inch column-pipe is sufficient to deliver it.

Drawing engines.

Second Seam.

The discovery of the Acadia seam was followed by the discovery of a second seam, underlying at about 160 feet, by Capt. Blacker of the Acadia colliery. At the pit sunk by him the following thickness was found:— Second seam.

	Ft.	In.
Shaly coal	3	10
Good coal	7	8
	11	6

The bench known as *good coal* seems, from the specimens I have seen, to be of a shaly character, and none that has come before me would be saleable. On the Carmichael area this is opened by only one trial-pit, now filled up.

AREA NO. 3.

Upon the No. 3 Acadia area no coal has been found, but from the presence, as proved by trial-pits, of the black shales overlying the Main seam, it is probable that the representatives of this and underlying seams occur beneath a portion of this area to the west of the McCulloch-brook fault. Of the size or character of the coal no information can be obtained without extensive prospecting. The only opening which is near this area is the Culton adit, and from the strike of the Culton seam at that point, it may be presumed that it will continue on to No. 3 area. Area No. 3.

Railway.

The Acadia Coal Company have built a fine single-track railway of about three and a half miles in length, the main line extending from the West slope to the track of the government railway at a point near Coal Mines station, and passing through the Acadia village near the McGregor colliery, with which it is connected by sidings. From the junction at the railway station the coal is conveyed over the government railway to the Acadia loading ground at Fisher's Grant, on the east side of Pictou harbour, near the entrance. The shipping wharf extends into the harbour 850 feet to 26 feet of water at low tide. It is a well built structure, 20 feet in height, with shutes at both sides and end, empty trains being made up on a centre track. Railway. Loading ground.

Buildings.

Thirty double houses have been provided for miners and labourers at the Acadia village, which is very tastefully laid out in regular streets and avenues, the houses being very substantially built, and of a much better class than it is usual to provide for like purposes. Buildings.

The rest of the plant at both slopes, including the blacksmith and machine shops, office building and overmen's houses, is very complete.

INTERCOLONIAL COAL MINING COMPANY OF MONTREAL.

Intercolonial Coal Company.

Two mining areas are owned by this company, the Bear Creek area to the south of the Carmichael area of the Acadia Coal Company, and the Sutherland area, which lies to the north of the area of the General Mining Association.

BEAR CREEK AREA.

Bear creek area.

The Acadia seam was opened upon this area soon after its discovery in 1865, at a point known as Campbell's pit, near the north line of the area, and from this pit, as worked by the then owners of the area, and subsequently by the agents of this company, a considerable amount of coal was taken for consumption in the immediate neighbourhood. After a careful survey by Mr. William Barnes of Halifax, a competent mining engineer, (which survey will again be alluded to) the company decided upon the location of the present colliery.

DRUMMOND COLLIERY.

Drummond colliary.

The erection of buildings and machinery at this colliery and the first work at the present slopes was commenced about November, 1867, since which time works of considerable importance have been erected, a railway has been built, and a large amount of coal (about 70,000 tons) has been shipped.

The section of the Acadia seam at this point is as follows, the measurement being taken in the air shaft of the colliery:

	Ft.	In.
Good coal with a smooth parting two feet nine inches from the bottom, (*full coal*)	5	9
Light gray soft fireclay; it varies slightly in thickness; (*holing*)	0	3
Good coal, top bench	5	6
Gray hard coal, giving a pink ash.	0	6
Good coal, second bench	4	6
Coarse coal, not worked	2	1
	18	7

UNDER-GROUND WORKINGS.

Under-ground workings.

The present workings consist of two working slopes driven about 900 feet from the crop of the seam, the dip being about 16° at the surface, decreasing to 14° at the lower level, at 730 feet from the surface. The size of these slopes is 9 by 9 feet, with a central barrier of coal between them of 28 feet, each slope having a single track and travelling-way. Main levels for two lifts have been driven from the slopes *north* and *south* upon the seam, the north levels being worked from No. 1 slope and the south from No. 2; thus far I believe the lower levels have been most extensively worked, a considerable amount of coal being left

near the crop for safety. I have not had an opportunity of examining a detailed plan of the workings, but my inspection of them would lead me to believe that the system of pillarage is planned with more than usual regard for safety. Both the post and stall and counterbalance systems of *getting* the coal were at first tried with a view of ascertaining their comparative economy, and I believe that Mr. Dunn has selected the counterbalance system for the future working of the mine.

But little water has as yet been met with, and it is at present raised by water cars, no pump having been found necessary.

Over-ground Works.

Over-ground works.

The arrangements at the surface seem exceptionally well planned and have given great satisfaction. At the head of the slopes a large heapstead or covered screening platform is erected for the separation of different sizes and qualities of coal, and for banking ou . The coal boxes are drawn on to this platform in trams of from five to twelve (holding from 500 to 600 pounds each) and thence delivered by dumps on to the screens, where the coal is separated, as at the Acadia colliery, into three sizes: round coal, nut coal and slack. The platform extends over eight railway tracks, four for each slope; its floor is level with the top of the bank, for banking out, and in shipping bank-coal a railway track is run along the foot of the bank, and from this level the bank cars are raised to the main platform in a cage lifted by a small donkey engine, which is also arranged to drive a circular saw for the car shop of the colliery.

Engines.

The drawing engines are horizontal connected engines of about 50 nominal English horse-power; they are of Scotch manufacture, and are fitted with an extremely ingenious arrangement of friction gearing, by means of which the two slopes may be worked independently, by one engine, a matter of great convenience.

Railway.

Railway.

The railway of this company extends from the Drummond colliery to their shipping wharf at Granton on the Middle River, near Abercrombie Point, the position of which will be seen on the map. The main line of single-track railway is laid with 56-pound rails, with the new steel scabbard joint, which has proved so successful on the Pictou and Truro branch of the Nova Scotia railway. This railway was built in 1868 by Mr. Joseph B. Moore, contractor, in the most complete manner, the track being well ballasted with broken sandstone and a coarse conglomerate from the cuttings near Waters's Brook, the culverts of cut stone, and the bridge of trestlework with cut stone foundations.

Rolling stock.

The rolling stock of this railway consists of three locomotives, miscellaneous platform and construction cars, and sixty new coal waggons carry-

ing from six to seven tons of round coal each, twenty of which were built at the Drummond colliery car shop. In connection with the railway are provided at the colliery, car shops, locomotive-sheds and weigh-houses. The length of the main line of railway from the colliery to the wharf is about seven and one quarter miles, which, with sidings, turn-outs and standing tracks at the colliery, will probably raise the total length of single track to about ten miles.

Shipping wharf.

The shipping wharf of the Intercolonial Coal Company is a fine structure of wood upon stone and crib-work piers, extending in a curve into the channel of the Middle River to about 22 feet of water. The arrangement at the platform of the wharf is such that there is a slight incline of one track downward from the shore to the end of the wharf, and thence a further down grade on a second track back to the shore, the design being that as fast as coal is required at the shipping places or *shutes*, the full cars are allowed to run by their own gravity to the point required, whence, on being emptied, they will again return by their own weight to the shore, to be made up into *empty* trains. They are switched back at the end of the wharf on to the *empty* or inside track, running parallel to the *full* track, upon which they are pushed by the locomotive in coming from the colliery. This arrangement has, I believe, given great satisfaction, as it results in a saving of the horses usually necessary for handling coal cars at the shipping wharves.

The railway and wharf were opened for traffic about the 1st of October, 1868, and before the close of navigation several thousand tons of coal were shipped. During the present season the colliery has been in successful operation, and a considerable quantity of the coal has found a market in the provinces of Ontario and Quebec.

In the description of the general distribution of the coal in the Bear Creek synclinal it has been stated that at a few hundred yards to the south of the Drummond Colliery the crop of the Acadia seam comes against the West fault. The fact that the crop of the seam was here lost upon a fault "with a S. W. upthrow and a bearing of N. 10° W." magnetic, (or N. 33° W. astronomical) was proved and stated by Mr. Barnes. A few yards to the west of the spot where the coal of the Acadia seam was lost another seam of inferior coal, about three feet in thickness, was found, and beyond it, to the south-west, a second fault with a south-west upthrow was observed, bringing up red and gray sandstones. These sandstones I have examined and believe to belong to the Millstone Grit series.

West fault.

The first fault mentioned appears to coincide in position and bearing with the general run of the West fault, and, as it will certainly be the western boundary of the workable coal, I have in the map shown it as that fault, but it is quite possible that here the great West dislocation may turn

a few yards, leaving a small patch of the lower portion of the coal measures to the west of Mr. Barnes' first fault, its throw being completed by the second fault found by Mr. Barnes, bringing up the Millstone Grit.

The amount of coal of the Acadia seam removed by this fault, as at present understood, will be unimportant. This is known from the fact that the measures overlying the seam have been traced along the east side of the fault, and as they dip at very low angles it is probable that only some 70 or 100 yards of coal next the crop will be cut off by the fault. No reason is at present known why the second levels from the Drummond colliery should not run around regularly to the south-eastern portion of the area.

SUTHERLAND AREA.

Sutherland area.

But little work has been done upon this area, and no coal has as yet been opened. It will be seen that the North fault runs diagonally through it, cutting it into two portions. To the south of this fault the area is probably underlaid with the lower seams or a portion of them. The Montreal and Pictou seam, and any seams which may be found above it, will, if no dislocation exist, turn to a westerly dip upon this area, and at a few chains from the east line their crops will come against the fault.

The coal in this area might, perhaps, be successfully worked in connection with the Montreal and Pictou area, and a small portion of the northern part of the area of the General Mining Association.

NOVA SCOTIA COAL COMPANY OF NEW HAVEN, CONNECTICUT, U. S.

Nova Scotia Coal company.

This Company own one mining right of three and one-half square miles in extent, known as the French Area.

FRENCH AREA.

French area.

This mining area is situate to the north and west of the Carmichael area of the Acadia Coal Company. The workings consist of a slope upon the Acadia seam, driven 236 feet from the crop, from which a few irregular working places have been opened and several hundred tons of coal raised. The angle of dip is here 28° at surface, increasing to 35° at the bottom of the slope. A section of the Acadia seam was measured about 140 feet down the slope, and is as follows, the measurements being reduced to thicknesses at right angles to the plane of the seam:

Section of Acadia seam.

ACADIA SEAM.

	Ft.	In.
Good coal, not seen, the thickness and quality being on the authority of Mr. T. French, agent of the Nova Scotia Coal Company.....	2	6
Good coal.....	4	8

	Ft.	In.
Dark brown arenaceous fireclay, compact and hard; the thickness varies, the average being	0	10
Good coal, finely laminated	2	9
Shaly coal and dark brown coarse arenaceous fireclay in thin beds, known as *stone parting*	0	9
Good coal, locally known as the *middle bench*	2	3
Dark brown arenaceous fireclay	0	0½
Coarse good coal, giving a reddish ash	1	0
Dark brown soft fireclay parting	0	0¼
Good coal with a coarse and somewhat *twisted* structure; the good quality of the coal is given on the authority of Mr. French	2	4
	17	2

SECOND SEAM.

Second seam.

The section of the second seam at the pit a short distance west of the Nova Scotia slope, is stated by Mr. French to be as follows:

	Ft.	In.
Shale and coal	3	0
Good coal	9	0
	12	0

NOVA SCOTIA COLLIERY.

Nova Scotia Colliery.

Until the present season the opening on the Acadia seam has lain idle, but the erection of works is now in progress, and it is hoped that the colliery will be in active operation by the opening of the season of 1870. A survey has been made and ground broken for a railway, and a wharf is being built near the Intercolonial Coal Company's shipping wharf on the Middle River. It is designed that the colliery shall be capable of shipping some 600 or 700 tons of coal per day.

Railway and wharf.

The exact position of the spot where the crop of the Acadia seam will be lost upon the West fault, upon this area is still an uncertainty. The seam has already been found 396 yards to the north-west of the working slope, and could probably be traced a short distance farther. As the angle between the strike of the seam and the bearing of the fault is very small, the dislocation will encroach but little on the *deep coal* at this mine, for a considerable distance from the slope. In this connection may be mentioned an adit on the right bank of McLeod's Brook near its junction with the Middle River, locally known as French's Tunnel. This was driven for some distance eastwardly upon a bed of several feet in thickness of black shale and shaly coal, which, at one time, was imagined to represent the Acadia seam. This bed is however situated to the west of the West fault, and it would appear to belong to the Millstone Grit. As it is supported by a *Stigmaria* underclay it may, in spite of its impurity, be considered a true coal seam, but is not likely ever to prove of any value.

West fault.

MONTREAL AND PICTOU COAL COMPANY OF HALIFAX, NOVA SCOTIA.

Montreal and Pictou Co.

The Montreal and Pictou area is situate to the north of that of the General Mining Association, to the west of the Sutherland area of the Intercolonial Company, and is bounded on the east by the east bank of the East River. The northern limit of the Productive coal measures upon this area is the line of the great North fault. As yet no regular works have been commenced, though the company have been at considerable expense in sinking a pit upon what has been known as the Montreal and Pictou, or Haliburton seam. From verbal information given me by Mr. Haliburton, Managing Director of the company, and a journal of progress kept by Mr. William Brain, former agent of the company, the following facts with regard to this pit are submitted.

Section vertical to horizon.

According to Mr. Brain's record, the following strata were intersected in sinking; the thickness being given *vertically to horizon*, the dip being S. 43° E. (or S. 20° E. mag.) < 65°. The descriptions of strata are based upon a personal examination of the pit *débris :*

	Ft.	In.
Bluish-gray argillaceous shale	13	0
Compact light-gray sandstone	0	10
Black argillaceous shale and fireclay interstratified with one another	10	0
Coal (bench *a*)	10	6
Black carbonaceous fireclay	10	6
Sandstone, the colour not given	3	0
Fireclay with arenaceous bands	3	0
Black carbonaceous shale	3	0
Coal (bench *b*)	9	0
Coarse coal and shale (bench *c*)	2	0
	64	10

Horizontal section.

At a depth of 100 feet from the surface, a cross-cut or *stone drift* was driven on the underlying measures, intersecting the following strata, the measurements being taken on a horizontal line :

	Ft.	In.
Fireclay	9	0
Coal (bench *d*)	2	6
Fireclay	9	0
Coal (bench *e*)	15	0
	35	6

Shaft sunk.

According to the record these strata must have been in the disturbed measures of a fault, as the section of the shaft shows angles varying from 30° to 85° of overturn or northerly dip. From the level at 100 feet, the shaft was sunk to a depth of 177 feet, without getting the benches of coal

d and *e*, and in the bottom of the shaft a bore-hole was put down 27½ feet further, passing through sandstones, shales and fireclays only. At a depth of 163 feet from the surface a cross-cut was then driven from the shaft to bench *a*, passing through bench *b*, which was only five feet in thickness. With regard to work done in this bench, the following information was obtained from Mr. Haliburton; the workings, being full of water at the time of my visit, could not be examined.

ross-cut.

"The upper bench (*a*) where cut by the stone drift from the pit was ten feet six inches in thickness, yielding three and a-half feet of workable coal; upon this bench a level was driven seventy yards south-west. The thickness was at one time reduced to two and a-half feet, after which it increased to twenty-five feet, yielding fourteen and a-half feet of workable coal, the size increasing and quality improving going westward."

Level.

Cross-cut and bore-hole.

"At sixty yards west of the pit a stone drift was driven across the dip through the underlying measures eighty-four feet, and a bore driven thirty-four feet farther without meeting any of the lower benches (*b*, *c*, *d*, *e*) of coal. The strike at the western face was due west (or S. 67° W. astronomical) and turning rapidly toward the north-west."

Fireclay.

In driving the western drift twelve feet of dark brown carbonaceous fireclay were intersected, of which some 300 tons were taken out and sold to the Crown Brick and Pottery Company, of New Glasgow, at $0.75 per ton, and I am told proved of very good quality. Eastward from the Montreal and Pictou pit the upper bench (*a*) was found to rapidly thin and deteriorate, and work in that direction was soon stopped.

In explanation of the facts just given it can only be said that it is probable an east and west dislocation runs quite near the Montreal and Pictou pit, bringing the lower benches (*b*, *c*, *d*, *e*) into the position in which they were found, the exact direction and dowthrow of which have not been properly observed while the workings were in progress.

A small seam has been proved upon this area upon the old road to Fraser Ogg's quarry, the thickness of which is given by the Montreal and Pictou Company's record as eighteen inches. The coal from this pit resembles the Steliar oil-coal from the Frazer mine of the Acadia Coal Company, and burns in much the same way, igniting with ease and throwing off small sparks or jets of flame; and it is possible that it is the representative of the Stellar seam on the north rise of the Albion trough. Its stratigraphical distance from the Montreal and Pictou seam appears to be about 200 feet, but with the possibility of intervening dislocations this may be far from correct.

Oil-coal.

I have already alluded to the possibility of coal beds being found overlying the Montreal and Pictou seam, and to several unproved crops which

are known to underlie the supposed Oil-coal; one, probably representing seam A of Section 4, is seen upon the old quarry road, near the brick-yard to the north of the Montreal and Pictou pit.

MESSRS. SINCLAIR AND HALIBURTON'S CULTON AREA.

Sinclair and Halliburton's Culton area.

Of the mining areas lying to the west of the East River, either wholly or partially underlaid with the workable coal seams, there remains to be noticed only one, the Culton area, lying to the south of the Intercolonial Coal Company's Bear Creek area.

Culton adit.

The Culton adit has already been described. This opening, with a bore-hole near it, seems to prove the existence of a seam of six feet in thickness, where undisturbed, of good coal, on the northern portion of the area. The probability of a second seam has already been alluded to, and if, as indicated, the Culton seam is the equivalent of the Main or Acadia seam, representatives of the lower seams of Section 4 should underlie a small portion of the area probably bounded by the West, the South, and the McCulloch-brook faults; but as no openings exist upon any such seams no statements can be given of their size or quality.

Appendix with analyses of coals.

In conclusion I would state that an Appendix to this Report is in course of preparation, in which descriptions and analyses of the different coals of this region will be given, together with the results of such practical trials of their economic value as steam and gas producers as I have been enabled to make; together with a collation of many facts and analyses already published which could not be conveniently introduced into the body of the Report. In the Appendix will also be noticed several deposits of iron ore in Pictou county, which have received examination during the past two seasons, with assays and analyses of the specimens obtained from them.

Notice of iron ores.

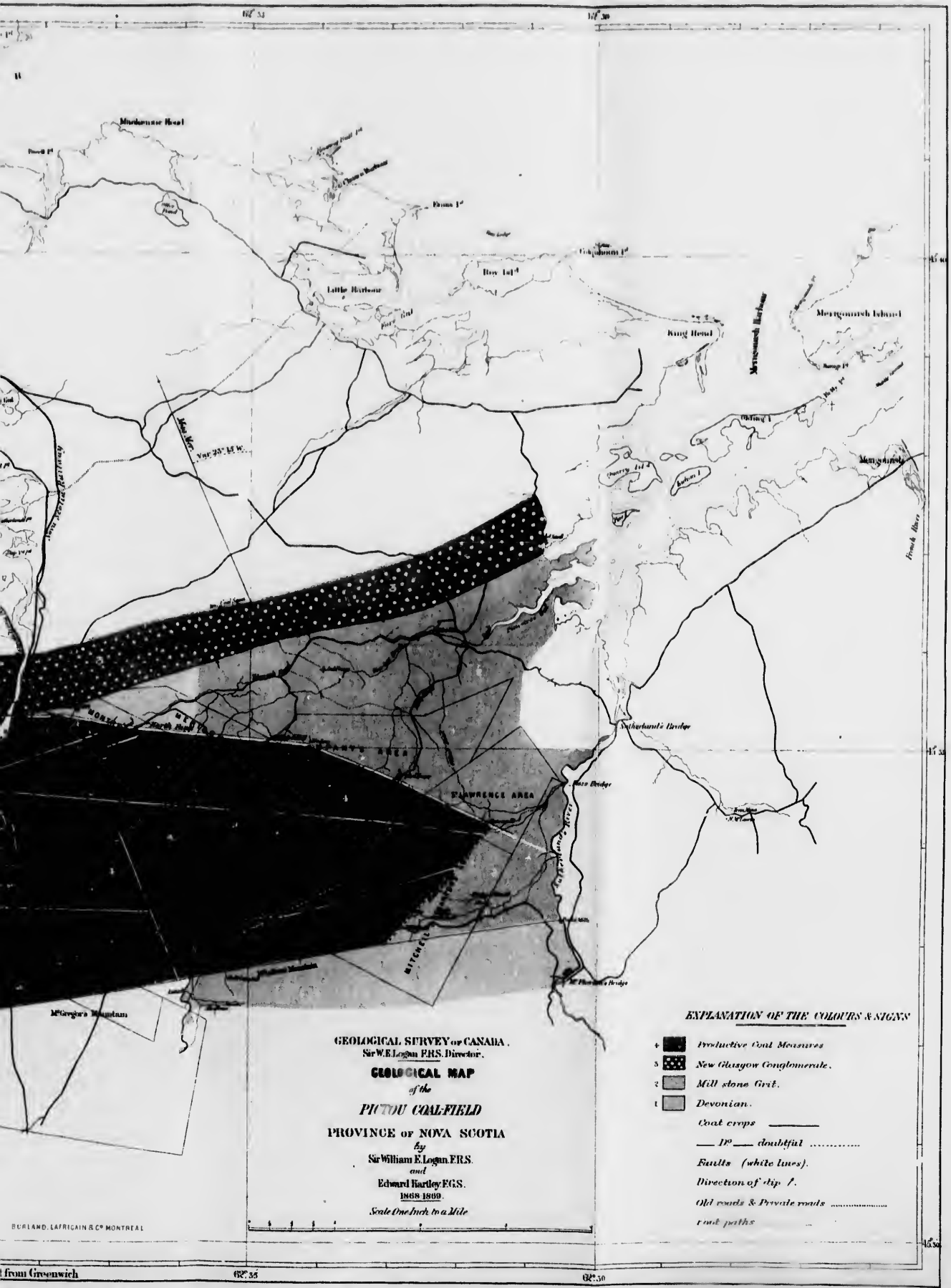
I have the honour to be,

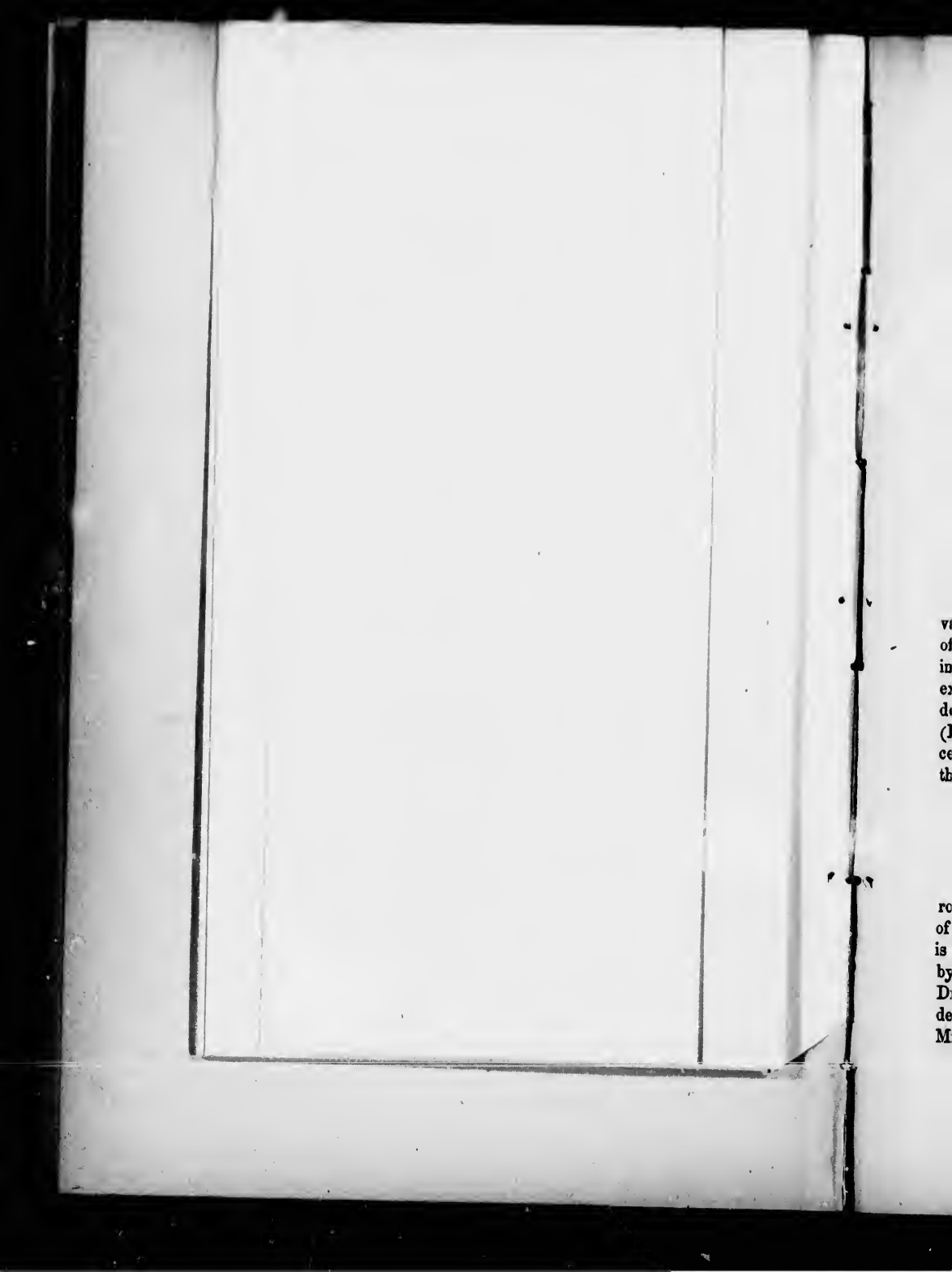
Sir,

Your most obedient servant,

EDWARD HARTLEY.


122° 47'
122° 40'
Longitude West from Greenwich
Lake Bryson P.O.
Aberarder P.O.
Loch Bryson
West River
Mackenzie Road
Mackenzie River
McGregors Mountain
Montreal
BURLAND, LAFRIGAIN & Co. MONTREAL


Pictou Harbour
Little Harbour
Roy Ind.
King Head
Merigomish Harbour
Merigomish Island
Merigomish
Var 25° 15 W.
Intervale Railway
French River
Sutherland's Bridge
Mass Bridge
Fraser Mills
Mitchell
McPherson's Bridge
McGregor Mountain
EXPLANATION OF THE COLOURS & SIGNS
4 Productive Coal Measures
3 New Glasgow Conglomerate.
2 Mill stone Grit.
1 Devonian.
Coal crops
Do doubtful
Faults (white lines).
Direction of dip /.
Old roads & Private roads
Coal paths
GEOLOGICAL SURVEY of CANADA.
Sir W.E.Logan F.R.S. Director.
GEOLOGICAL MAP
of the
PICTOU COAL-FIELD
PROVINCE of NOVA SCOTIA
by
Sir William E.Logan F.R.S.
and
Edward Hartley F.G.S.
1868-1869.
Scale One Inch to a Mile
BURLAND, LAFRAIGAIN & Co MONTREAL
from Greenwich
62°.55
62°.50



REPORT

ON THE

COALS AND IRON ORES

OF

PICTOU COUNTY, NOVA SCOTIA,

BEING AN APPENDIX

TO

REPORTS ON THE PICTOU COAL FIELD,

BY

MR. EDWARD HARTLEY, F.G.S.,

MINING ENGINEER TO THE GEOLOGICAL SURVEY.

The following Report will furnish information concerning the economic value of the coals of Pictou County, Nova Scotia, together with a notice of some localities of iron ore likely to become of interest from their proximity to the Pictou coal-field; these deposits of iron ore having received examination during my field-work of the years 1868–69. It will be divided into three sections :—(I) Descriptions and analyses of Pictou coals; (II) Reports of practical trials of Pictou coals as steam and gas-producers, and for other purposes of the mechanic arts;—(III) Iron ores and their occurrence in Pictou County.

I.

DESCRIPTIONS AND ANALYSES OF PICTOU COALS.

A number of published papers and reports contain analyses of coals rom the Pictou region; but with few exceptions, these publications are out of print, or otherwise inaccessible to the general public. In this section it is proposed to bring these scattered analyses together, supplementing them by a series made by myself during the spring of 1869, in the laboratory of Dr. T. Sterry Hunt, F.R.S., chemist to the Survey, and a few more careful determinations made still later, in Dr. Hunt's laboratory, by his assistant, Mr. Gordon Broome, F.G.S., Associate of the Royal School of Mines.

Classification of analyses.

Analyses of coal may be divided into three classes; (a) practical analyses in the large way, or the determination of the proximate constituents of the coal, that is, the moisture, volatile matters, coke and ash, by burning a large quantity; (b) proximate analyses in the laboratory, or the result of the drying, coking, and incineration of a few grains in a small crucible; and (c), ultimate analyses, being the careful determination of the ultimate elements of a coal or other fuel, such as carbon, hydrogen, oxygen and nitrogen; the class (c) being, of course, the most satisfactory for calculations of the theoretical value of a coal.

Of the analyses now given, by far the greater number belong to the second class, (b) in which may be included all those made in the Survey laboratory, as the great expense and amount of time necessary for their completion has rendered both practical and ultimate analyses out of the question. Although far from satisfactory as accurate *measures* of the true value of coals, the crudest analyses enable us to form some idea of their character, and, in the absence of practical trials, furnish us with elements on which to base an approximate opinion as to what practical service they are best fitted to perform.

Method of analysis.

The method of analysis pursued in the examination of the samples of coal obtained in the Pictou coal-field by myself, was somewhat as follows: Drying in a water-bath at a temperature of 212° Fahrenheit, to expel moisture; heating to bright redness in a closed crucible to obtain the percentage of volatile combustible matter; and finally incineration in an open crucible to obtain the amount of ash. In most cases two different samples of each coal were examined, one being coked by a sudden application of a high heat, to obtain the largest possible amount of volatile matter or *gas*, irrespective of its character, the quantity of coke being thus reduced to a minimum; while in treating the second, the heat was applied with the greatest care, and raised very gradually, by which treatment the gases obtained are more highly carburetted, and in smaller quantity than when the heat is suddenly applied. In a few cases, determinations of sulphur have been made, but from this impurity the greater part of the coals now worked in the Pictou region are quite free. The general very light colour of tneir ashes attests their freedom, when properly selected, from sulphur in combination with iron, as *pyrites*, and among the coals examined, the ashes of but few contain an appreciable amount of sulphate of lime, being generally very silicious or sandy in the best coals, and therefore not inclined to form a clinker adherent to the grate-bars. No full analysis of the ashes of any of these coals has yet been made, so far as I am aware.

Theoretical evaporative powers.

The calculations of the *theoretical evaporative power* of the different coals analyzed, are based upon the fact, that in burning bituminous coals of the class under consideration, in an ordinary furnace, such as has always been

used for comparing their results in steam production with those of anthracites and other fuels, the combustion of the volatile matters of the coal does not, in most instances, produce more than enough heat to effect their volatilization, and therefore *theoretically*, the value of the coals for steam purposes, depends on their content of fixed carbon, or the carbon remaining in their coke when the coal is heated in close vessels.*

Method of calculation.

The calculation may be made as follows:—Let the weight of coke, less ash, in parts of one unit of coal—that is, the percentage of fixed carbon—be expressed by C; the co-efficient of the heating power of carbon by c, and the co-efficient of the latent heat of steam at 212° F., by l,—then:—

$$\frac{C \times c}{l} = x$$

x being the theoretical evaporative power of the coal, or the number of pounds of water which one pound of coal should evaporate from a temperature of 212° Fahrenheit, *theoretically*.

Values of co-efficients.

The values given to the co-efficients used, vary with different authors. To c—expressing the number of units of water which the combustion of one unit of pure carbon will raise 1° Fahrenheit—Regnault gives the value of 13,268, while by Dulong† it is given as 12,906.

To the co-efficient l, Regnault gives the value 965.7°; while the experiments of Professor W. R. Johnson indicate for it a value as high as 1030°.‡

Official reports on coals.

In my own calculations the values of Regnault have been used, although later experiments have shown a further modification,§ inasmuch as these values have been used in the Reports of the British Commissioners on the Naval Steam-Coal Enquiry,¶ with whose results a comparison will be most valuable, although in the American reports, (published before Regnault's

*Practical experiments have already shown that North Country (or Newcastle) coals, burnt in proper furnaces calculated to prevent smoke, give a practical evaporative effect higher than the theoretical power based on this supposition, and I hope to be able at some future time to show a similar result with our coals; but as, with an ordinary furnace, the method of calculation to be given approaches correctness, and more especially as I wish to compare the theoretical values of these coals with results obtained from experiments conducted some years since, I still, for the time, adhere to the old rule.

†Vide Comptes Rendus, tom. 7, page 871, et seq.

‡W. R. Johnson's Report on American Coals, 1844, p, 22.

§The late researches of Favre and Silbermann (*vide* Ann. Ch. Phys. (3) xxxiv, 357—xxxv. 15—xxxvii. 405.), and of Andrews (Phil. Mag. (3) xxxii. 321, 425), have slightly modified Regnault's values. For a full digest of their results, see the admirable article on FUELS, by Prof. B. H. Paul, in Watt's Chemical Dictionary, 1864, vol. II., p. 718, et seq.

¶Reports of Sir Henry T. De la Beche and Dr. Lyon Playfair to the Lords Commissioners of the Admiralty, on trials of coals, 1848 and 1852. See also Johnson's Coal Trade of British America, 1850, p. 78

exhaustive memoir* appeared,) the values of Dulong for c, and Johnson for l, have been adopted.

Value of theoretical results.

The results obtained by these different values do not differ as greatly from each other as they will be found to differ from actual results, and they are useful only in the absence of reliable practical trials. In coals of this class, *i.e.* bituminous coals with 25% to 35% of volatile matter, these theoretical indices are generally slightly higher than figures obtained from furnaces of low-pressure boilers where no special arrangements are made for "*smoke-consumption*"—as it is called, or more properly, smoke-prevention, for smoke once formed cannot be consumed.

Values from ultimate analyses.

In cases where ultimate analyses are to be obtained, the theoretical value of *all* the combustible matter in a coal may be obtained by the following formula:—

$$\left(\frac{C \times 13268}{965.7}\right) \quad \left(\frac{H - h \times 62470}{965.7}\right) = x$$

in which C represents the entire carbon content, both fixed and volatile, H the quantity of hydrogen in a unit of fuel, and h the quantity of hydrogen which will correspond to the oxygen in the coal; x expressing, as before, the number of pounds of water theoretically convertible into steam, from 212°, by one pound of coal, provided all the combustible constituents of the coal could be rendered available; or, in a word, the highest possible evaporative power of the fuel under any circumstances.

Expression of mechanical force.

The values of x, as used in the two preceding formulæ, or an evaporative value given by practical trial, may be converted into an expression of mechanical force by the formula:—

$$(Wn) \times 965.7 \times 782 = y,$$

in which W represents water, of which n pounds are evaporated by one pound of coal, (thus giving Wn the value of x in the preceding formulæ), and y representing the number of *foot-pounds* of work theoretically possible.†

*Regnault. *Relations des experiences entreprises • • • pour determiner les principales lois et les données numériques qui entrent dans le calcul des machines à vapeur. Paris*, 1847. See also a translation of the portion on the latent heat of steam at different pressures, in the Works of the Cavendish Society, vol. I.

† This formula is deduced from the fact that n pounds of water, multiplied by 965.7°, or the co-efficient of the latent heat of steam at 212° F., indicates the number of pounds of water which would be raised 1° Fahrenheit by the combustion of one pound of coal. The number 782 arises from experiments on the mechanical force denoted by the elevation of temperature of a pound of water 1° F., that force being equal to 782 lbs. raised one foot high, according to the careful experiments of Mr. Joule on the friction of oil, water and mercury.—(Extract from Report of British Commissioners, from which the formula is taken.)

Theory and practice.

It should be distinctly understood that no calculations based upon mere analyses can take the place of trials of the coals in the large way as steam and gas-producers, for smelting, heating iron, or for any other practical use; for though, as a rule, these theoretical values furnish us with a general idea of the use to which a coal is best fitted, it is of not unfrequent occurrence that theory and practice differ greatly. For further information on practical values of fuel, I would refer the reader to the works of Prof. W. R. Johnson, and to the second section of this Report.

COALS OF THE WEST SIDE OF THE EAST RIVER.

COALS FROM THE MAIN SEAM, ALBION MINES.

No favourable opportunity offered during my stay in this district for an examination of samples of the coal of the Main seam, which would enable me to satisfactorily separate the peculiar varieties of the different benches. I therefore reproduce the careful section prepared by Dr. Dawson, which well illustrates the character of all the different descriptions of coal of this seam.*

This section was prepared from an examination of a column of coal from the Main seam, extracted for the New York Industrial Exhibition of 1852 by Mr. Henry Poole, then manager of the Albion mines.

SECTION OF MAIN SEAM, BY DR. J. W. DAWSON.

Dawson's section of the Main seam.

		Ft.	In.
1.	Roof shale; vegetable fragments and attached *Spirorbis* (in specimen)..	0	3
2.	*Coal*, with shaly bands.....	0	6½
3.	*Coal*, laminated; layers of mineral charcoal and bright coal; band of ironstone balls in bottom.....	2	0
4.	Worked in Old Mines: *Coal*, fine cubical and laminated; much mineral charcoal.....	3	2
5.	Worked in Old Mines: Carbonaceous shale and ironstone, with layers of coarse coal (*holing stone*), remains of large fishes and coprolites. This bed varies much in thickness.....	0	4½
6.	Worked in Old Mines: *Coal* laminated and cubical; coarse towards bottom.....	9	3
7.	Ironstone and carbonaceous shale in the coaly layers, and trunks of *Lepidodendron*, *Ulodendron*, *Sigillaria*, etc., all prostrate.....	0	8
8.	*Coal*, laminated as in No. 6; line of ironstone balls in bottom.....	1	2
9.	*Coal*, laminated and cubical; a few small ironstone balls; many vascular bundles of ferns in this and underlying coal.....	6	7
10.	Ironstone and pyrites.....	0	3
11.	*Coal*, laminated and cubical, as above.....	10	3
12.	*Coal*, coarse layers of bituminous shale and pyrites.....	1	0
13.	*Coal*, laminated, with a fossil trunk in pyrites.....	2	1
14.	*Coal*, laminated and cubical, with layers of shale passing downwards into black slickensided underclay, with coaly bands	2	3

* Acadian Geology, second edition, pp. 331-32.

	Ft.	In.
15. Underclay, to bottom of specimen	0	10
Total	40	8
Vertical thickness	38	6

Coal of Main seam.

The general character of the coal from the Main seam is that of a highly bituminous caking coal, generally of a laminated structure, and showing much mineral charcoal on the planes of deposition. Although much impurity exists in the form of shale, ironstone, and arenaceous material carrying pyrites, these may be easily separated from the good coal in taking out the different floors of the seam. The coal raised is also carefully examined at the shutes, any refuse or shale being thrown aside before the coal is put into railway cars for shipment.

Specific gravity.

The specific gravity of this coal is stated by Dr. Dawson to be from "1.288 (which is that of the best coal extracted,) to 1.447 (which is that of the coarsest coal that has been worked)."*

The mean specific gravity of six samples, taken from the top, middle and bottom of the seam, in the central part of the mines, is stated, on the same authority, as 1.325, which agrees exactly with the result of some trials made for the American Government, by Prof. W. R. Johnson, whose researches will receive attention in the second section of this Appendix.

The following, being an abstract of the statements of Dr. J. W. Dawson in his Acadian Geology, is extracted from Prof. How's late work on the Mineralogy of Nova Scotia, published by authority of the Provincial Government:—

"Numerous analyses were made by Dr. Dawson in 1854, shewing the character of the Albion Mines coal from different parts of the upper floor of the mine, and also the varieties existing throughout the whole thickness of their Main seam, in a series of assays of coals taken at distances of one foot in thickness. The general results were that the best coal was found on the N. W. side of the old workings, deterioration taking place at either extremity of the workings of the upper floor. In all parts of the mine the lower coal was inferior to that of the middle of the seam, and still more so to that of the upper part (above the "holing stone"), or "fall coal" of the miners. On the west, this fall coal disappeared, or was reduced to insignificant thickness. The assays made to show the variations in thickness of the whole seam were on coal taken at this western part. This valuable series of assays of the coal of this seam, so familiar to the world, is here given.

* Acadian Geology, p. 333.

"*Assays of Samples taken at the distance of one foot in thickness in the Main Seam of coal of the Albion Mines, Pictou, by Dr. Dawson.*" Dawson's analyses.

	Volatile by rapid coking.	Volatile by slow coking.	Fixed carbon.	Ashes.
1. Coal	26·0	19·9	63·8	16·3
2. do	27·8	24·1	63·8	12·1
3. do	27·4	25·7	60·0	14·3
4. do	27·2	25·0	65·5	9·5
5. do	25·8	25.1	64·8	10·1
6. do	25·2	24·9	62·5	12·6
7. do	27·4	22·0	68.5	9·5
8. do	26·8	22·9	66·7	10·4
9. do	27·0	23·9	61·3	14·8
10. Carbonaceous shale	16·4	15·9	26·3	58·8
11. Coal	28·8	25·8	59·7	14·5
12. do	27·2	25·4	62·5	12·1
13. do	27·6	24·7	62·5	9·8
14. do	26·6	23·9	61·0	15·1
15. do	26·8	23·1	65·1	11·8
16. do	28·8	24·9	62·3	12·8
17. do	30·4	26·0	65·0	9·0
18. do	26·0	26·1	63·0	10·9
19. do	26·0	25·0	66·3	8·7
20. do	26·8	22·7	63·6	13·7
21. Coarse coal	25·8	23·3	58·3	18.4
22. do	27·2	22·5	60·3	17·2
23. Coal	29·4	22·6	64·3	12·1
24. Coarse coal	25·8	22·4	57·6	20·0
25. do	25.8	23·1	60·2	16·7
26. do	27·8	21·9	54·8	23·3
27. Coal	27·0	24·3	65·5	10.2
28. do	25·6	22·4	65·0	12·6
29. do	25·8	22·7	62·7	14·6
30. do	27·2	23·1	67·4	9·5
31. do	32·6	22·4	66·5	11·1
32. Coarse coal	22·2	21·5	50·4	28·1

"The coal above the "holing stone" is not found at the part from whence these coals were taken, as before explained. At the N.W. side of the old workings it is three feet thick, and has this composition :—

	Dawson.
Moisture (hygroscopic water)	1.550
Volatile combustible matter	27.988
Fixed carbon	60.837
Ash	9.625
	100.000

"In these assays we have a most instructive and interesting set of experiments, the most complete of the kind, so far as I know, ever made on any bed of coal of considerable thickness. 'All the coals afford a fine vesicular

coke, and their ashes are light-gray and powdery, with the exception of those of the coarse coals, which are heavy and shaly. The worst defect of this coal is its containing rather a large quantity of bulky ashes, which causes it to be less esteemed for domestic use than, on other grounds, it deserves. It is very free from sulphur, burns long, and with a great production of heat, and remains alight, when the fire is low, much longer than most other coals.' "*

coord-pit coal

These analyses, it will be seen, are of coals from the older workings of the Crushed mines and Dalhousie pits. Of the coal obtained from the new Foord pits, I have made the following analyses :—

	Hartley.	
	By fast coking.	By slow coking.
Hygroscopic water,.....	1.73	1.80
Volatile combustible matter.....	28.18	25.12
Fixed carbon.....	62.94	65.70
Ash (light-gray).....	7.15	7·38
	100.00	100.00
Coke.....	70.09	73.08
Theoretical evaporative power.....	8.62 lbs.	9.03 lbs.
Sulphur (in average of coal).....		0.32 per cent.

The specimens analyzed were hand-samples from the bank at the Foord pits, and believed to fairly represent the whole mass, which supposition is confirmed by the agreement of my assays with the following analysis by Prof. How, of King's College, Windsor, Nova Scotia, of a sample of one barrel, sent him by Mr. Hudson, Chief Manager of the General Mining Association.

How's analysis.

" *Coal from Foord pits, Main seam.* An average of the large sample sent, gave :—

	How.
Moisture.....	1.48
Volatile combustible matter.....	24.28
Fixedcarbon.....	66.50
Ash.....	7.74
	100.00
Coke.....	74.24
Sulphur.....	0.55
Theoretical evaporative power.....	9.13 lbs.
Specific gravity, average of three specimens.....	1.294

" It follows that this is, for various reasons, a valuable coal. The volatile combustible matter is such in amount and character as to promise well in

*H. How, Mineralogy of Nova Scotia, p. 18–20.

gas-making. The coke is firm and abundant, and the high theoretical evaporative power, shewing the number of pounds of water which one pound of coal ought to evaporate from a temperature of 212°F., (rather above the practical average of 37 Welsh coals), places the coal very high as a steam-producer. The amount of sulphur is decidedly low, obviously an important fact as regards domestic use, gas-making, and preservation of grate bars. The coal lights up readily in a parlour stove, cakes moderately, and gives a hot lasting fire; the ash is nearly five per cent. less than in coal from the same seam examined by Prof. Johnson, in 1842-43, and one or two per cent. less than coal from the *best parts* of the seam, tested by Dr. Dawson, in 1854. This is an important feature, as the large quantity of light bulky ash was then considered the worst defect of the coal. The ash consists chiefly of sandy matters; there is so little lime that there will be but little tendency to form clinkers. The specific gravity is high enough to show good storage character. One cubic foot broken for use should weigh about 52½ lbs., and one ton of 2,240 pounds should occupy, in the same state, about 42½ cubic feet space in storage.

"From its hardness, and the appearance of the contents of the barrel after about 100 miles of railway carriage, I conclude that the coal would bear handling and land-carriage without making much *small*, or dust."*

These remarks and analyses comprehend all that can be theoretically said of the value of the Foord-pit coal. I may, however, state that the coke from this coal is of exceptionally good character, and though all the coals from this seam furnish good coke, that from the Foord-pit coal seems to take the first rank, from its coherent and yet very porous texture. It is very light, of a silvery-gray colour, and a metallic lustre.

COALS FROM THE DEEP, OR CAGE-PIT SEAM, ALBION MINES.

Deep-seam coal.

In general appearance, the coal of the Deep seam much resembles that of the Main. A section of the different beds of this seam was examined by Dr. Dawson, in 1854, of which he publishes the following description, with assays of the different beds.†

SECTION OF DEEP SEAM, BY DR. J. W. DAWSON.

Dawson's section of the Deep seam.

1. Gray argillaceous shale (roof).
2. Tender laminated coal; much mineral charcoal.
3. Laminated compact coal; less mineral charcoal.
4. Laminated compact coal; less mineral charcoal.
5. Carbonaceous ironstone, crusts of *Cyprids*.

*Extract from letter of Prof. H. How, of King's College, (late chemist to the British Admiralty Coal Enquiry), to James Hudson, Esq., G.M.A.

†Acadian Geology, p. 335-336.

6. Laminated compact coal; much mineral charcoal.
7. Laminated coarse coal.
8. Laminated compact coal.
9. Laminated coarse coal.
10. Laminated compact tender coal.
11. Laminated compact coal.
13. Laminated compact hard coal.
14. Laminated compact hard coal; thick layer of mineral charcoal.
15. Laminated compact coal.
16. Laminated compact coal; much mineral charcoal.
17. Laminated compact coal; much mineral charcoal.
18. Shaly coal; impressions of plants.

The results of assays of the above samples of coals taken, at distances of one foot, in the Deep seam are given in the following table:—

Analyses.

		Dawson.			
		Volatile by rapid coking.	Volatile by slow coking.	Carbon fixed.	Ashes.
2.	Good coal	24.8	21.0	67.6	11.4
3.		25.2	25.2	67.3	7.5
4.		26.4	23.9	70.8	5.3
5.	Ironstone and coal	26.8	27.5	18.5	54.0
6.	Coarse coal	23.2	20.5	59.1	20.4
7.		23.6	20.4	48.0	31.6
8.	Good coal	26.2	22.4	70.3	7.3
9.	Coarse coal	25.2	21.1	49.3	28.6
10.	Good coal	24.8	20.4	68.9	10.7
11.		24.8	22.3	64.3	13.4
12.	Coarse coal	23.4	20.5	51.2	28.3
13.		23.0	20.1	55.3	24.6
14.	Good coal	27.4	23.9	68.1	8.0
15.		29.0	22.9	71.5	5.6
16.		26.8	21.9	69.6	8.5
17.		24.6	19.9	63.8	16.3
18.	Shale and coal	17.6	21.1	23.0	55.9

Coal now worked.

The following analysis of a small sample of the coal now being worked at the western face, has been made by Mr. Broome:—

	Broome. Coking.	
	Rapid.	Slow.
Volatile matter	28.1	25.5
Coke	71.9	74.5
	100.0	100.0
Hygroscopic water		1.296
Volatile combustible matters		25.443
Fixed carbon		61.650
Sulphur		.861
Ash		10.250
		100.000
Specific gravity		1.33

The ash from this sample contained 75 per cent. of matter insoluble in hydrochloric acid, which was chiefly aluminous silicate. Iron was estimated in the soluble portion, which, by the volumetric method, gave of metallic iron equal to 2.762 per cent. of the ash. Supposing all the iron to exist in this coal as pyrites, this amount would correspond to 0.4243 per cent. of sulphur in the coal. As experiment gave a larger proportion, it is evident that some of the sulphur present exists as a sulphate, probably of lime. The ash was gray, with a faint tinge of pink. This colour of ash is usual with the coal of this seam. Coke, by rapid carbonization, hard; by slow coking, a pulverulent mass was obtained. Character of ash.

To this analysis may be added the results of Prof. How, from an examination of a large sample; probably a better average of the whole seam than the specimen examined by Mr. Broome:—

"*Coal from Deep, or Cage-Pit Seam.*—An average of the large sample sent, (one barrel), gave:— How's analysis.

	How.
Moisture	2.54
Volatile combustible matter	20.46
Fixed carbon	68.50
Ash	8.50
	100.00
Coke	77.0
Sulphur	1.39
Specific gravity (average of three specimens)	1.345
Theoretical evaporative power	9.41 lbs.

"This is an excellent coal, especially for domestic and steam purposes. As compared with that of the Foord pit, it gives a larger quantity of coke, and its theoretical evaporative power is decidedly higher, so that it must prove a valuable steam coal. It burns well in a stove, affording a strong enduring heat; its ash not being much above that of the Foord-pit coal, it will also be found superior for domestic uses to the coal formerly raised at your mines. The sulphur is not high, as compared with many coals, though it is rather above the average of that in Welsh steam coal.

"The ash is chiefly sand; there is very little lime, so there will not be much clinker formed. From the high specific gravity, one cubic foot of the coal should weigh about 53 lbs., when broken, and a ton of 2,240 lbs. should be stored in about 42 cubic feet.

"The coal is harder and less easily broken than that from the Foord pit."*

* Extract from a letter from Prof. How to James Hudson, Esq., G.M.A.

COALS OF THIRD AND PURVIS SEAMS, ACADIA MINES.

Third and Purvis seams.

These seams are now abandoned, and no analyses have been made of the coal from them, as no samples lately taken from the seam could be procured.

COAL OF THE MCGREGOR SEAM, ACADIA MINES.

The following extract is from the Report of Mr. Hoyt to the Acadia Coal Company, 1866 :—

McGregor seam.

"It has been found that the thickness of this coal (the McGregor seam) increases as we progress westwardly, but diminishes as we work to the east.* The same remark will also apply to the quality of the coal. At present, only the upper divisions of the seam are worked. The bottom coal, which is of a coarse nature, is unsaleable, but would be very suitable for iron-smelting†; and in case of the developement of the iron deposits on the East River of Pictou, a good market would be created for it. The slaty band, between the top benches, is a source of much inconvenience and expense in mining; and with all the care exercised in picking, this foreign matter will, to some extent, get mixed with the good coal, which is thereby injured in character for gas purposes.

"The quantity of ash produced by the two top benches presents a marked contrast in the character of the coals, as will be seen by the following analyses, which have been obtained from the former proprietor, Mr. J. D. B. Frazer :"‡

Analyses.

	First bench.	Second bench.
Volatile matter	22.50	23.30
Fixed carbon	65.70	70.00
Gray ash	11.80	6.70
	100.00	100.00
Coke	77.50	76.70
Specific gravity	1.334	1.301
From these analyses the theoretical evaporative power would be	9.03	9.62

This coal cokes well when the better portions of the seam are selected. A very large amount of iron pyrites exists in the slaty portions of the seam, which, if not most carefully removed, makes the coal worthless as a gas coal. Careful attention in hand-picking, will probably obviate this objection to the coal.

* See p. 96 of my Geological Report.

† I have not analysed this coal from the bottom of the McGregor seam, but it appears to contain too much sulphur and ash to be very suitable for iron smelting.

‡ Name of analyst unknown to me.

The theoretical evaporative power resulting from the second analysis above given is large; it should render the coal a good steam coal, if the pyrites were removed.

COAL AND OIL-COAL FROM THE STELLAR SEAM.

Stellar oil-coal seam.

On page 70 of the Geological Report, it is stated that the Stellar coal seam of the Acadia mines has the following section:—

Section.

	Ft.	In.
Good coal	1	4
Stellar oil-coal	1	10
Bituminous shale	1	10
	5	0

Divisions of stellar seam.

These three divisions of the seam are quite separate and distinct in character. The substances from each were examined some time since by Prof. How, who first described the peculiar substance forming the middle bench, to which, from a likeness in some of its qualities to the so called oil-coals, torbanite and albertite, he has given the name of stellarite, from its throwing off sparks or stars of fire when lighted. From the three benches Prof. How obtained the following results:—*

Analyses.

	How.		
	Coal.	Stellarite.	Shale.
Volatile matters	33.58	66.56	30.65
Fixed carbon	62.09	25.23	10.88
Ash	4.33	8.21	58.47
	100.00	100.00	100.00
Moisture		.23	
Specific gravity		1.103	

Coal bench.

Coal. The coal appears to be merely an ordinary fat caking-coal, with an unusually small percentage of ash for this region, but the bench being thin, the value of the seam depends principally on the two lower divisions, stellarite, and oil-shale.

Stellarite bench.

Stellarite. This peculiar substance was first known and worked at these mines by the former owner, the late Mr. J. D. B. Frazer, of Pictou. It appears to be an earthy bitumen, or, to quote Dr. Dawson, "a fossil swamp-muck or mud," † which he has elsewhere‡ shown, is the character of the earthy bitumens and highly bituminous shales of the coal formation generally.

* How, Mineralogy of Nova Scotia, p. 24.

† Acadian Geology, p. 339.

‡ See Dawson, "*On the conditions of accumulation of coal.*" Journal Geol. Soc. xxii. p. 95 et seq.

Oil-shale bench.

Bituminous shale or oil-shale. This is a rather heavy brownish-black shale. The following analysis and remarks thereon, include both this bench and the stellarite.

The first series is taken from Mr. Hoyt's Report to the Acadia Coal Company for 1866. Analyses under the heading of No. 1 refer to stellarite, No. 2 to the oil-shale :—

Analyses for oil, etc.

	Wallace.* No. 1.	No. 2.
Volatile matters	68.38	38.69
Fixed carbon	22.35	8.26
Ash	8.90	52.20
Sulphur	.05	.25
Moisture	.32	.60
	100.00	100.00
Specific gravity	1.079	1.568
Weight per cubic foot	67¼ lbs.	97 lbs.
Crude oil per ton	126 gallons.	63 gallons.
Gravity of oil	.844	.850
Coke, per cent	31.25	60.46
Ash in the coke of stellarite, 28.48 per cent	....	....

	Penny.† No. 1.	No. 2.
Volatile matter	67.26	34.16
Fixed carbon	24.03	12.30
Ash	8.40	52.00
Sulphur	.11	.74
Water	.20	.80
	100.00	100.00
Specific gravity	1.069	1.612
Weight per cubic foot	66¾ lbs.	100 lbs.
Crude oil per ton	123 gals.	60¾ gals.
Gravity of oil	.844	.850

QUANTITY OF OIL BY VARIOUS TRIALS. (per ton.)

(1) Trial by J. De W. Spurr, St. John, New Brunswick, (No. 2) crude oil	74 gals.
(2) " by J. Howarth, Boston, Mass., by steam process, crude oil.	65 "
(3) " by F. Macdonald, Portland, Maine, (No. 2), crude oil..	50 "

Comparison with other oil-coals.

For comparison, the following results from these and other oil-coals are introduced ; the table is taken from How's Mineralogy of Nova Scotia :

* Prof. Wallace, of Glasgow, Scotland.

† Prof. Penny, Andersonian University, Glasgow, Scotland.

	Crude oil per ton.
Union oil-coal of West Virginia affords.....	32 gals.
Elk River " " " " "	54 "
Kanawha " " " " "	88 "
Leshmahagow cannel, Scotland "	40 "
Albertite, New Brunswick, ...	92 to 100 "
Torbanite, Scotland, ...	116 to 125 "
Stellarite, ...	53 "
" No. 2 (shale)	50, 60¾, 63, 65, 74 "
" No. 1, ...	123 to 126 "
" picked samples gave in Boston.....	199 "

In practical working at the Frazer mine the result was about 60 gallons of crude, and from 30 to 35 gallons of fine clarified oil to the ton.

It will be noted that the three oil-coals, or bitumens, known as torbanite, albertite, and stellarite, in the list just given, appear to afford the best results in oil-manufacture. It will, therefore, be of interest to compare full analyses of these three, forming a class by themselves, and again to compare this class with other mineral combustibles from which they differ to a greater or less extent. This subject has been thoroughly investigated by Prof. How, and the following tabulation of analyses, and conclusions drawn therefrom, are taken from his late work. Although most appropriately introduced here, many of the facts will be found useful for comparison with coals of other seams, and the remarks on the theoretical value of fuels is also of general interest.

Dr. How's remarks on oil-coals.

" Having, on account of my former connection with the British Admiralty Coal Enquiry, been one of those engaged to furnish chemical evidence in the famous first trial in Edinburgh of the question whether the mineral known as " Boghead coal," found at Torbane Hill, Linlithgowshire, should properly be called a coal, I was naturally much interested on the discovery of the stellar oil-coal, and got ultimate analyses made of it and of the " Albert coal," also the subject of a trial on the ground that it had been improperly called coal. These analyses were very kindly made for me through Prof. Anderson of Glasgow, who generously met my deficiency in the necessary apparatus, which I had not brought out with me. The results were most interesting, especially when compared with those obtained from bituminous and cannel coals. As to the former, I selected from those I had made in the Admiralty Enquiry, analyses of English, Scotch, and Welsh bituminous coals, and as to the latter, analyses of English and Scotch cannels made by other chemists. The following table shews the differences which obtain between these minerals in proximate and ultimate analysis, and in specific gravity, and the ratio existing between the two most important constituent elements :—

Mineral.	Locality.	Specific gravity.	Proximate analysis.				Ultimate analysis.				Ratio of carbon to hydrogen.	Authority.
			Volatile matters.	Fixed Carbon.	Ash.	Carbon.	Hydrog.	Nitrogen.	Sulphur.	Oxygen.		
Welsh bituminous coals.	Duffryn	1.326	15.70	81.04	3.26	88.26	4.66	1.45	.77	0.60	100: 4.82	H.How.
	Newydd	1.310	25.20	71.56	3.24	84.72	5.76	1.56	1.21	3.52	100: 6.79	"
	Ebbw Valo	1.275	22.50	76.00	1.50	98.79	5.15	2.16	1.02	0.39	100: 5.73	"
Scotch bituminous coals.	Grangemouth	1.290	43.40	53.08	3.52	79.55	5.28	1.35	1.42	8.58	100: 6.61	"
	Fordel	1.025	47.97	48.03	4.00	79.58	5.50	1.18	1.46	8.33	100: 6.93	"
English bituminous coals.	Broomhill	1.025	40.80	56.18	3 07	81.70	5.17	1.84	2.85	4.37	100: 7.55	"
	Lydney	1.283	42.20	47.80	10.00	73.52	5.69	2.04	2.27	6.48	100: 7.73	"
Eng. cannel.	Wigan	1.276	39.64	57.66	2.70	80.07	5.53	2.12	1.50	8.08	100: 6.90	Vaux.
Scotch cannels.	Lesmahagow	1.251	56.70	37.26	6.03	73.44	7.62	....	1.14	*	100: 10.43	Miller.
	Capledrae	....	....	....	25.40	56.70	6.80	1.90	0.35	8.80	100: 11.99	A. Fyfe.
Torbanite.	Torbanehill, Scotland	1.170	71.17	7.65	21.18	66.00	8.58	0.55	0.70	2.99	100: 13.00	H. How
Albertite.	Hillsboro, New Brunswick	1.091	54.39	45.44	0.17	87.25	9.62	1.75	....	†	100: 11.02	Slessor & How.
Stellarite.	N. Glasgow, Nova Scotia	1.103	66.58	25.23	8.21	80.96	10.15	0.68	....	‡	100: 12.53	"

* Nitrogen and oxygen 11.76. † Sulphur (if any) and oxygen, 1.21. ‡ N, S, and oxygen .68.

"In the paper in question I pointed out that the true comparative value of combustible minerals, while partly indicated by the relative amounts of volatile matter and fixed carbon, is only truly shewn when account is taken of the oxygen; which is sometimes large in quantity, as is seen above, and is reckoned as volatile matter, to the credit of the mineral, while its real effect is reduction of value. I showed that when the hydrogen equal to the oxygen present is deducted, taking only those cases where there is an apparent equality in the ratio of carbon to hydrogen, the last three minerals in the table above, stand apart from the rest, thus:—

Ratio of carbon to hydrogen after deducting hydrogen equal to oxygen present.

Cannel coal from Wigan	100 to 5.65
" " " Lesmahagow	100 to 8.71*
Capeldræ	100 to 10.05
Torbanite from Scotland	100 to 12.43
Albertite " New Brunswick	100 to 10.85
Stellarite " Nova Scotia	100 to 12.43

* Allowing two per cent. for nitrogen.

and that theoretically they should be excellent 'oil-coals,' as is abundantly shewn by experience."*

Description of stellar seam.

The size of the stellar-coal bench in the oil-coal seam varies from our or five inches in thickness to some two feet, and its content of oil varies also. As a rule, this seam appears to improve going eastward, as stated by Mr. Hoyt. The general appearance of the stellar coal is peculiar; it is irregularly bedded, the different layers seemingly interlaced, giving it a sort of an entangled appearance, or a structure like

* How, Mineralogy of Nova Scotia, p. 25–26.

felt. Sometimes the layers are much curved, and have smooth surfaces like slickensides, which appear to have been produced by lateral movements, corresponding very nearly with the plane of the bed, rather than by vertical motion, the better portions generally possessing this peculiarity, whence the statement in many notices of this substance that the *curly* oil-coal is the best. The surfaces of these curved faces have a bright, resinous lustre, and a brownish-black colour, while a block sawn across shews a uniform *dead*-brown surface. It breaks with a splintery fracture, very irregularly, but approximately with the surfaces of deposition; the streak has a brown colour and a dull resinous lustre.

A large splinter of this mineral may be easily lighted with a match, and burns with a very bright, carbonaceous flame, throwing off sparks like stars, (whence the name), and leaving but a small amount of coke, from which, on burning off the fixed carbon, a grayish-white ash is obtained. Further remarks on the use of this mineral in gas-making, will be found in Section II of this Report.

COAL OF THE ACADIA SEAM, ACADIA COLLIERY.

Acadia steam coal.

ACADIA STEAM COAL. The principal value of this coal, is (as its name indicates) as a steam-coal, though a portion of the seam at this colliery may be suitable for gas-making. As the character of the coal as a steam-producer will receive the fullest attention in the second section of this Report, it has been deemed unnecessary to make any analyses of it as yet, though when time permits I hope to obtain a full series of analyses of the coals from different benches of the seam, by examination of a series of specimens presented by Mr. Hoyt. In the meantime I offer my practical locomotive and steamer-trials, with some other tests of considerable interest, in Section II, which I consider will give abundant evidence of the excellence of the Acadia steam-coal.

Third bench.

Only one analysis of this coal has been made in the laboratory of this Survey, that of samples of the coal taken from the third bench, or the four feet immediately underlying the fireclay parting. (See page 97 of my Geological Report.) These specimens were selected for analysis, because I believe this bench to be better fitted for gas purposes than the rest of the seam, being apparently the softest coal afforded by the Acadia seam at this colliery.

The analysis has lately been made by Mr. Broome, with the following results:—

Analysis

	Broome. Coking.	
	Rapid.	Slow.
Coke	65.12	68.70
Volatile matters	34.88	31.30
	100.00	100.00

Hygroscopic moisture	2.100
Volatile combustible matter	32.274
Fixed carbon	57.570
Sulphur	.506
Ash, (pinkish white)	7.550
	100.000
Specific gravity	1.32

The coke by rapid carbonization was firm, but by slow heating a pulverulent mass was obtained.

This analysis shows that a portion of the seam at the Acadia colliery will coke well, and that it contains sufficient volatile matter to make a gas-coal. The greater part of the seam is a much harder coal than the specimen examined, and, when all the benches are mixed, does not coke satisfactorily in open heaps, and is therefore sold only as a *free-burning* or steam-coal. Were it desirable, however, I think the third bench could be easily separated in the working of the seam.

The coal of this seam is rather more compact in appearance than that from the Main at the Albion mines, and shows but little mineral charcoal on the deposition-planes. The cleat planes and cross fractures of the coal are usually very brilliant, and do not show the laminæ or deposition-planes very clearly.

COAL OF THE ACADIA SEAM, DRUMMOND COLLIERY.

Drummond coal.

From a careful examination of the different benches of coal in the working, and subsequent examinations of a series of large samples of the coals presented by Mr. Dunn, manager of the Intercolonial Coal Company, I am

Description of seam worked.

enabled to present the following description of this fine seam of coal, as worked at the Drummond Colliery. With my description of the benches, analyses will be given, forming what I believe to be the most careful and complete series of assays ever made of different benches of any seam of considerable thickness. These analyses have lately been made in the Survey laboratory by Mr. Gordon Broome, F.G.S., chemical assistant to Dr. T. Sterry Hunt, chemist and mineralogist to this Survey.

Description and analyses of the benches of the Acadia seam at the Drummond Colliery, Pictou County, Nova Scotia.

Roof-shale.

Roof-shale; black, highly carbonaceous shale, giving a dark brown streak, and containing *Spirorbis* and *Cythere* shells, with *Antholites*, *Lepidodendron*, *Lepidostrobus*, not specifically determined, and *Cordaites borasifolia.*

Top coal.

1. *Top coal;* not taken out in the workings. This is left in as a support for the roof. Coal good, principal partings show mineral charcoal, and have

rather a dull lustre. On cleat surfaces the general lustre is brilliant, but the laminæ of deposition show plainly in lines of brilliant and dead black. The joints are rather irregular, generally inclined about $<80°$ to 85° to the deposition-planes, but the surface next to the lower parting, (*a smooth parting,*) shows two regular sets of joints at right angles, giving the coal a *cubical* appearance.

Thickness of *top-coal* bench, 2 feet, 6 inches.

ANALYSIS NO. 1; TOP COAL.

Volatile at 100 C., (moisture)	.72	Analysis.
Volatile at 220° C.,	7.83	
Total volatile, 1. By slow coking	27.56	
" " 2. By fast coking	30.19	
Coke, 1. By slow coking	72.44	
" 2. By fast coking	69.81	
Volatile matter	29.928	
Fixed carbon	60.350	
Ash, (gray)	9.460	
Sulphur	.262	
	100.000	
Specific gravity	1.309	

2. *Fall Coal;* immediately above the fireclay parting, or *holing*, this being the first bench taken down. Coal good; surfaces of deposition show dead-black patches of mineral charcoal, with bright points, and patches of bright bituminous matter. Cleat surfaces brilliant, the joints running in two systems, giving this bench in some parts of the workings, a cubical, or as it is technically called, *dicey*, structure. The surfaces of one system of joints show oblong or oval scars, as of *shrinkage*, while of the second system the surfaces are quite regular and brilliant. Fall coal.

Thickness of *fall-coal* bench, 3 feet, 3 inches.

ANALYSIS NO. 2; FALL COAL.

Volatile at 100° C., (moisture)	1.56	
Volatile at 220° C.	13.61	Analysis.
Total volatile, 1. slow coking	29.78	
" " 2. fast coking	31.92	
Coke, 1. slow coking	70.22	
" 2. fast coking	68.08	
Volatile matter	31.694	
Fixed carbon	60.320	
Ash (gray)	7.560	
Sulphur	.426	
	100.00	
Specific gravity	1.328	

First bench.

3. *First bench;* (below the holing.) Coal good; all of the surfaces, whether of cleat and fracture, are brilliant, and the deposition-planes show very little mineral charcoal. The joints are irregular in direction and angle, cutting the coal up into oblique prisms. This is a remarkably clean and bright coal.

Thickness of *first bench*, 4 feet.

ANALYSIS NO. 3; COAL OF FIRST BENCH.

Analysis.

Volatile at 100° C., (moisture)	1.80
Volatile at 220° C	16.45
Total volatile, slow coking	26.49
" " fast coking	34.11
Coke, slow coking	73.51
" fast coking	65.89
Total volatile matter	33.526
Fixed carbon	55.390
Ash, (gray)	10.500
Sulphur	.584
	100.000
Specific gravity	1.327

Second bench.

4. *Second bench;* (so marked in specimens sent me.*) Good coal, laminated and cubical; in some parts of the seam the cubical structure is very distinct. On the surfaces of the deposition-planes, there is some mineral charcoal, but all the other surfaces are of a brilliant black.

ANALYSIS NO. 4; COAL OF SECOND BENCH.

Analysis.

Volatile at 100° C., (moisture)	1.31
Volatile at 220° C	14.61
Total volatile, slow coking	28.73
" " fast coking	31.02
Coke, slow coking	71.27
" fast coking	68.98
Total volatile matters	29.973
Fixed carbon	60.310
Ash, (gray)	8.670
Sulphur	1.047
	100.000
Specific gravity	1.343

Third bench

5. *Third bench;* the lower two feet of good coal, next above the coarse coal; forming the bottom of the seam. Coal good, laminated distinctly; it is not so bright as the first and second benches, though an excellent coal. Deposition-planes are a dull black, showing much mineral charcoal. Cleat

*In my Geological Report, p. 100, I have associated this bench with the one below it, which is now called the third bench.

planes show laminæ of deposition plainly, and in the joints, in many cases, are seen scales of calc-spar.

ANALYSIS NO. 5; COAL OF THIRD BENCH.

Analysis.

Volatile at 100°C., (moisture,)	1.43
Volatile at 220°C	13.12
Total volatile, slow coking	29.14
" " fast coking	31.32
Coke, slow coking	70.86
" fast coking	68.68
Total volatile matters	30.756
Fixed carbon	59.890
Ash (gray)	8.790
Sulphur	.564
	100.000
Specific gravity	1.335

6. *Coarse-coal bench*, bottom of seam; thickness about 2 feet, 9 inches. Coal coarse and shaly; deposition-planes show uniform dead-black surfaces. Coal breaks with irregular fractures in all directions, giving fracture surfaces of a dull lustre and brownish black colour. Not worked. Coarse-coal bench.

ANALYSIS NO. 6; COAL OF THE COARSE-COAL BENCH.

Analysis.

Volatile at 100°C., (moisture)	1.58
Volatile at 220°C.,	undet.
Total volatile, slow coking	29.89
" " fast coking,	31.81
Coke, slow coking	72.44
" fast coking	69.81
Total volatile matters	32.81
Fixed carbon	37.16
Ash, (red)	31.03
Sulphur	undet.
	100.00
Specific gravity	17.65

The cokes of Nos. 1, 2, 3, 4, 5, obtained by the carbonization of the coal in the small way, (in a crucible), were all strong and light, whether by slow or rapid heating, though of course more compact with a slow carbonization. When heated rapidly the coke swells greatly, and is of a silvery-gray colour and metallic lustre. All these benches should, if properly managed, furnish an excellent coke in the large way. With the single exception of the Foord-pit coal, no coal from this region which I have examined has given as good a coke in the crucible. The coke from No. 6, or coarse coal, is soft and brittle. Cokes.

The amount of ash in the different samples is lower than the average Ash.

of Pictou coals, and the sulphur-content is, in samples I., II., IV., V., decidedly low. The coal of the second bench appears to give the greatest amount of sulphur, being somewhat over the average of the best Welsh coals, but in the coal of the whole seam, when mixed together, the amount of sulphur will be found to be exceptionally small.

Drummond coal for gas-making.

From the amount of volatile matter, as shown by these analyses, these coals, (*i. e.* the good coals of the seam,) should all belong to the class of gas-coals; in the first bench, No. 3, the content of volatile matter is very large, and about equal to the average of Newcastle coals, when rapidly carbonized. A reference to the report of Mr. Thompson, of the Pictou gas-works, on this coal, (which is published in Section II of this Report,) will show that in this case the conclusions of theory agree with practical results.

With regard to their use as steam-producers, theory gives the following indices of their evaporative powers:—

Theoretical evaporative powers.

I.	Fixed carbon	60.35	per cent	= 8.29	lbs. water to	1 of coal.
II.	"	60.32	"	= 8.29	lbs. "	"
III.	"	55.39	"	= 7.61	lbs. "	"
IV.	"	60.31	"	= 8.29	lbs. "	"
V.	"	59·89	"	= 8.27	lbs. "	"

It will be seen that a remarkable uniformity exists between the coals of I., II., IV., V., and that their theoretical evaporative powers are rather high for coals of this class, while III. falls rather below the average in fixed carbon. In this connection, however, I would draw attention to the fact that coals of this class are now burnt so as to give an evaporative power considerably above the theoretical index calculated from the fixed carbon of the coal alone. This subject has already been incidentally referred to in the introduction to this Section,* and will also receive special attention in Section II.

COAL OF THE ACADIA SEAM FROM THE NOVA SCOTIA COLLIERY.

Nova Scotia Co.'s Coal.

A section of this seam, giving details of the character of the coals of the different benches, has been included in the Geological Report, † and the following analyses of three specimens of the coal, by Prof. B. Silliman, of Yale College, New Haven, Connecticut, have been sent me by Mr. F. W. Northrop, Secretary of the Nova Scotia Coal Company:—

Silliman's analysis.

	SILLIMAN.		
	(1) Top.	(2) Middle.	(3) Bottom.
Volatile matters	32.68	32.39	33.45
Fixed carbon	62.08	62.40	61.41
Ash	5.24	5.21	5.14
	100.00	100.00	100.00

* See note on North Country coals, page 111.

† Pages 103-104 of the Geological Report.

From these analyses the theoretical evaporative power of the different samples would bo :—

Of No. 1, 8.53 lbs.;—of No. 2, 8.57 lbs.,—of No. 3, 8.44 lbs.

In the letter accompanying these analyses, Prof. Silliman makes the following statements :—

"The coke is firm and strong, while the ashes are light coloured, and so nearly free from oxide of iron as to warrant the belief that they will not give much clinker when the coal is used in a furnace. The amount of sulphur in the coal was not determined, as the quantity is too slight to render an experiment in the small way of any practical value."

Change in the Acadia seam.

It would appear from these analyses that there is a change in the character of the coal of the Acadia Seam between the Acadia and Nova Scotia collieries similar to that between the Acadia and Drummond collieries, and if the specimens analyzed by Prof. Silliman were fair representative samples of the whole seam, this should be, theoretically, a good gas-coal.

COAL OF THE MONTREAL AND PICTOU SEAM.

MONTREAL AND PICTOU COLLIERY.

Montreal and Pictou Co's. coal.

The works of this company having been abandoned before my visit, and the pit being full of water, during my stay in the region I was unable to procure samples of the seam or seams met with in the workings. The following note by Prof. How is, I believe, the only reliable information at present attainable concerning this coal :—

How's analyses.

"*Coal of the Montreal and Pictou Mines.* I examined several samples of the coals raised on the first opening of the seams; the following is an abstract of my Report made to the company as respects the qualities of the coals.

First bench.

"Sample No. 1, from the first bench, gave :—

Moisture	4.40
Volatile combustible matter	24.95
Fixed carbon	61.07
Ash	9.58
	100.00
Coke	70.65
Theoretical evaporative power	8.39

"This coal has considerable evaporative and heating power, and would give a moderate amount of gas of good illuminating quality. The appearance of the coal is much in its favour; some that I saw taken from the seam was very clean and bright.

"Sample No. 2, from the second bench, gave :—

Second bench.

Moisture	5.47
Volatile combustible matter	19.93
Fixed carbon	68.55
Ash	6.05
	100.00
Coke	74.60
Theoretical evaporative power	9.41
Specific gravity	1.36

"This was an extremely bright and clean coal. Its very high evaporative power makes it occupy a good position among British and American coals for steam purposes."*

COAL OF THE MONTREAL AND PICTOU OIL-COAL SEAM.

Montreal and Pictou oil-coal seam.

On page 106 of the Geological Report, mention is made of a small seam known on the Montreal and Pictou area, which I am inclined to identify with the Stellar seam of the Acadia mines. I have been unable to procure a good sample of the oil-coal from this seam, but a small specimen taken from the out-crop on the quarry road, much weathered and by no means fairly representing the seam, has been analysed by Mr. Broome with the following result:—

Analysis.

	Broome.
Volatile at 100° C., (moisture)	2.40
Volatile at 200° to 250° C	34.20
Total volatile matter	47.35
Fixed carbon	34.05
Ash, (very red and ferruginous)	18.60
	100.00

Description.

This substance is, in external character, very much like the stellarite. It presents the same dead-brown fracture, and shows glistening points of bituminous matter, which, on being ignited, melt and drop from the forceps. The facility of its ignition and continuity of combustion of a small piece, when removed from the flame in which it has been lighted, is only equalled among the oil-coals of the region, by the stellarite, and these facts, together with the results of Mr. Broome's analysis, tend to confirm my identification of the seams.

COAL OF THE CULTON SEAM; CULTON ADIT.

Coal of the Culton seam.

I have been unable to obtain a specimen of the coal of this working. Its character has been described to me by several who have burnt it, as that of an exceptionally good, and very highly bituminous coal.

* How, Mineralogy Nova Scotia, p. 27-8.

COALS OF THE EAST SIDE OF THE EAST RIVER.

COALS FROM MCBEAN'S EIGHT-FEET SEAM, MCBEAN'S SLOPE.

First Bench. Upper twelve inches of the seam.

Coals of McBean's 8-feet seam.

First bench.

The coal is a bituminous coal, with dead-black planes of deposition, showing little mineral charcoal. It is inclined to be a little shaly, but the cleat and cross-fracture surfaces are brilliant. The following analysis is the result of an examination of two specimens from quite near the out-crop :—

Analyses.

	Hartley. I.	II.
Hygroscopic water	1.57	2.67
Volatile combustible matter	29.29	28.65
Fixed carbon	52.38	49.66
Ash (white)	16.76	19.42
	100.00	100.00
Coke	69.14	65.08

These samples analysed were taken by myself from the seam, and were apparently an average of the bench. The coal burns well, forming a very hot flaming fire, and the ash, though bulky, is perfectly white, free from iron, and would fall at once through grate bars. No sulphur was discovered by ordinary tests. The coke does not hold together well.

Second bench, (about twelve inches below first bench.)

Second bench.

In appearance this coal is similar to the last, except that there appears to be no mineral charcoal visible on the planes of deposition, and the lustre of the cleat planes is very brilliant. The specimens analysed are from the slope about 40 feet from the crop, and show scales of calc-spar in the joints. Analysis I is from the top of the bench. Six inches below is a smooth parting, and analysis II, is from coal just below the parting.

Analyses.

	Hartley. I. Top of Bench.	II. Bottom.
Hygroscopic water	2.87	1.94
Volatile combustible matter	27.20	23.95
Fixed carbon	54.86	57.17
Ash (white)	15.27	16.94
	100.00	100.00
Coke	70.13	74.11

Bottom bench (lower six feet of seam).

Bottom bench.

This coal shows but little tendency to break with the lamination, and no mineral charcoal is seen, even the deposition-planes being brilliant. Fracture conchoidal. It burns freely, giving a very hot fire ; the ash is very light, sandy and not inclined to clinker ; it would fall at once through the grate bars of a furnace. No sulphur was found by ordinary tests.

The samples analysed were taken about 50 feet from the crop. The coke, if the coal is properly carbonized, is very fair. The following analyses of averages have been made :—

Analyses.

	Hartley. I.	Hartley. II.
Hygroscopic water	2.22	3.00
Volatile combustible matter	30.23	29.61
Fixed carbon	59.70	59.51
Ash (white)	7.85	7.88
	100.00	100.00
Coke	67.55	67.39

This coal should make an good gas-coal, as the percentage of volatile matters is quite large in comparison with many of the coals of the district. I am not aware that any practical trial has ever been made of it as a gas-producer. From its rapidity of combustion and freedom from sulphur, it would also appear to be well fitted for ordinary steam purposes.

COAL OF THE GEORGE MACKAY SEAM, MARSH COLLIERY.

George Mackay seam.

This coal is coarsely laminated; the deposition-planes have a very dull lustre, and show a great many patches of mineral charcoal. The cleat planes are inclined $<83°$ to the bedding; the joints show many scales of calc-spar, which is not adherent to the coal, but crumbles under the finger.

Coal of Marsh Colliery.

The following analyses of two specimens from the Marsh pit, 240 feet deep, and striking the coal seam about 1,000 feet from the crop, show this coal to be of very good quality, notwithstanding its rather coarse appearance :—

Analyses.

	Hartley. I.	Hartley. II.
Hygroscopic water	none.	none.
Volatile combustible matter	29.72	29.98
Fixed carbon	62.28	62.15
Ash, (buff coloured)	8.00	7.87
	100.00	100.00
Coke	70.28	70.02

The percentage of ash is decidedly low. A trace of sulphur was found, but being, probably, under one-half of one per cent., was not estimated. As the specimens examined do not coke particularly well, it would appear that this coal is best fitted for a steam-coal.

COALS OF LAWSON'S SEAM; LAWSON'S SLOPE.

Lawson's seam.

The specimens examined were taken from the slope sunk by Mr. J. P. Lawson, M.E., for the Montreal and New Glasgow Coal Company, on the

left bank of Potters' Brook, near the Merigomish telegraph road. At this working, the seam, as measured by me, was divided into the following benches:—

	Ft.	In.	
Cannel coal, (varies in thickness,) about	0	6	Section at Lawson's slope.
Mineral-charcoal bench	0	2	
Good coal	2	7	
Coarse (but good) coal	0	5	
	3	8	

Cannel-coal bench.—This coal appears to be a true cannel, being of a homogeneous texture, and dead grayish-black colour. The fracture is conchoidal, lustrous, streak brownish-black. In some places this cannel becomes shaly, breaking roughly with the deposition-planes, which are a dull black and in many cases tinged dark red with iron rust from iron pyrites, which occurs in small lenticular masses; cleat planes vertical to the bedding. One specimen shows a coprolite. A picked sample of this bench gave:— Cannel-coal Bench.

	Hartley.	
Hygroscopic water	.47	Analysis.
Volatile combustible matter	41.18	
Fixed carbon	48.19	
Ash, (reddish or purple)	10.16	
	100.00	

This specimen gave a very large quantity of very highly carburetted gas, but the coke is not of the best quality.

Mineral-charcoal bench. Interlaminations of mineral charcoal and bright bituminous coal form the material of this bench. The specimens examined show small veins of calc-spar in the joints of the coal, which are in many cases inclined at an angle of only 45° with the bedding. This bench shows a great deal of iron pyrites, coating the patches of mineral charcoal with a bright film, and giving them the appearance of having been gilded. Not analysed. Mineral charcoal bench.

Good-coal bench. Colour of coal dull black, very compact and heavy, with occasional patches of mineral charcoal. It shows but little tendency to break with the planes of deposition, and has generally a sub-conchoidal and sometimes a ragged fracture. The specimen examined contains a great deal of sulphur, in the form of iron pyrites, which if present in the mass of the coal, would altogether unfit it for steam or domestic uses. It burns, however, with a very bright and hot fire, though the ash is very bulky, and sometimes chokes the fire if not properly cleaned. Good-coal bench.

The following analysis of this coal is given in a report by Dr. J. W. Dawson, to the owners of the East River coal area:—

Dawson's analysis.

	Dawson.
Volatile matter, (moisture included)	25.4
Fixed carbon	50.0
Ash	24.6
	100.0

The ash from this coal is generally red or reddish-gray.

Coarse-coal bench.

Coarse-coal bench. The coal of this bench is very coarse in texture, having two sets of cleavage joints, very distinctly marked, which, with the planes of deposition divide it up into small cubical blocks, giving it the appearance known technically as *dicey*. The surfaces of the coal along the joints are generally rendered very dull in colour from the presence of fire-clay from the underclay of the seam, which softens when exposed to the atmosphere or percolating water, and is forced by the superincumbent pressure up into the open joints of the coal, presenting the phenomena of a *creep*, on a very small scale. This coal, were it not for its tendency to crumble (from its open texture), would be an especially good coal, as may be judged from its extreme lightness. The following analysis of a specimen from this bench presents a most remarkable contrast in content of ash (in spite of the fireclay in its joints) to the overlying bench :—

Analysis.

	Hartley.
Hygroscopic water	1.82
Volatile combustible matter	28.47
Fixed carbon	63.93
Ash, (buff-coloured)	5.78
	100.00

A determination of ash in another sample, gave 6.07 per cent.

COAL FROM THE "OLD FRAZER MINE." *

Foster seam.

I have not examined the coal from this seam, but on the authority of Dr. Dawson, it is stated to be "a good coal of uniform quality." † He distinguishes the seam in his Report, as the *Foster seam*, and gives the following analysis of the coal:—

Dawson's analysis.

	Dawson.
Volatile matter, (including water)	29.0
Fixed carbon	53.4
Ash, (reddish gray)	17.6
	100.0

* Report of Sir William E. Logan, p. 44.

† Report of Dr. J. W. Dawson to East River Coal Company.

COAL OF THE RICHARDSON SEAM, (PIT AT THE CROWN POTTERY.)

Richardson coal.

In appearance this coal is rather coarsely laminated, and its only tendency to break is roughly with the deposition-planes. In colour it is jet-black, the only perfectly black coal examined, and in the specimens analysed, all the surfaces, whether of deposition-planes or fracture, were brilliant, showing no trace of dead-black mineral charcoal, a very unusual thing with coals of this district. It is the most highly bituminous *true* coal of the district (so far as I am aware,) and I should judge from the analysis that it would be an admirable gas-coal, for which purpose it should be tested. It gives a very good coke, and the ash is very light, perfectly white, and silicious or sandy, and therefore will not be inclined to clinker. On the whole this seems to be a coal of remarkable purity, if fairly represented by the specimens I have seen. The pit not being open during my visit, samples were taken from a small heap of coal lying beside it, which however, had been for some time exposed to the weather. The following is an analysis of an average of these samples:—

Analysis.

	Hartley.
Hygroscopic matter	.76
Volatile combustible matter	38.84
Fixed carbon	55.81
Ash, (white)	5.09
	100.00
Coke	60.90

No sulphur was detected by ordinary tests. The content of ash, it will be observed, is lower than in any other coal of the district of which an analysis is given in this Report, with a single exception. Should the Richardson seam be proven over any considerable area, it would seem probable that, although quite small, it might be profitably worked with fair prices of coal, especially if taken out in connection with a valuable bed of fireclay, which underlies it a few feet, and which has already been worked to a small extent for pottery and fire-brick manufacture, by the Crown Brick and Pottery Company of New Glasgow.

UPPER OIL-COAL OR OIL-SHALE SEAM.

Oil-shale seam.

The substance included in this seam varies very greatly in external character between the two extreme points where it is known, at Haliburton's pit on the Marsh Brook, and at Andrew Patrick's old slope on McLellan's Brook, a short distance below the Fulling-mill bridge.

OIL-COAL FROM ANDREW PATRICK'S MINE.

Andrew Patrick's oil-coal.

The oil-coal from this mine occurs both shaly and *curly*, the latter description appearing to be the most valuable. That portion having the curly texture much resembles the stellarite in appearance, but is much heavier, and has a lighter brown colour. It weathers a very dark gray. The following analysis has been made by Mr. Broome of some large samples selected by Sir William E. Logan in 1868:—

	Broome.
Volatile below 200° Centigrade, water and some oil,....	.67
Volatile at 200° C., (oil).....	14.73
Total volatile matter.....	33.91
Fixed carbon.....	6.11
Ash (grayish-brown).....	59.88
	100.00
Coke.....	66.09
Specific gravity	1.747

This oil-coal has been used in the manufacture of burning-oil, I believe, but I am not aware of the quantity of oil produced per ton.

OIL-COAL OR SHALE, FROM THE MARSH BROOK.

Oil-coal from the Marsh Brook.

This substance appears to be an argillaceous shale, of a grayish-black colour, giving a brownish streak; the bedding is not well marked, except on surfaces of fracture, where the lamination can be traced by numerous small brilliant points, apparently bituminous, which are included between the laminæ. A thin section of this oil-shale under the microscope presents the appearance of a dark brown or black ground, nearly opaque, with numerous spots of yellow, which are translucent; the black ground being the shale, and the yellow points the included hydrocarbonaceous matter. The following analyses of this substance have been made, the first being of a specimen procured in 1868, by Sir William E. Logan, from the pit on the Marsh Brook known as Haliburton's pit:—

Analysis.

	Hartley.
Hygroscopic water.....	1.02
Volatile combustible matter.....	27.44
Fixed carbon,.....	9.26
Ash, (grayish-brown, shaly).....	62.28
	100.00
Specific gravity.....	1.68

Since the above analysis was made, I have procured other specimens from the same pit, one of which was analysed by Mr. Broome, with this result:—

	Broome.	
Volatile at 100° C, (water and some oil)	.596	Analyses.
Volatile at 200° C	11.250	
No. 1, Rapid coking.		
Total volatile matter	40.600	
Fixed carbon	.400	
Ash, (grayish-brown)	59.000	
	100.000	
No. 2, Slow coking.		
Total volatile matter	35.540	
Fixed carbon	5.260	
Ash	59.200	
	100.000	

The above results show that this shale is composed almost entirely of volatile matter and ash, the amount of fixed carbon being dependent on the rapidity of carbonization. This shale has been tested for oil, but the results I have not heard. Theoretically, it should be a valuable oil-shale.

II.

PRACTICAL TRIALS OF PICTOU COALS.

Value of practical results.

In the first portion of Section I, I have already drawn attention to the great importance of practical trials of coals as steam and gas-producers, and for other purposes of the industrial arts; and I have incidentally mentioned that several series of experiments on coals, with a view of ascertaining their evaporative value, had been carried out, so far as the coals of Great Britain and the United States were concerned, by the British and American governments, respectively. My attention was especially called to this matter during my examination of the Pictou district, while endeavouring to collect materials for a report on the coals of that region; by the almost total ignorance prevailing, of what work the coals could practically perform, or for what work they were best fitted. With one exception no figures could be obtained which would prove any of the coals to be valuable as steam-coals, that exception being the values furnished by a trial incidentally made (for comparison) by the American Government, during the series of trials of United States coals;—of the Albion-mines coal shipped in 1843 or 1844, when the upper twelve feet of the Main seam was the only coal worked. Although fully satisfied, from observing the success with which the coals were burnt, in the region, under stationary, locomotive, and marine boilers, that many of the coals were well fitted for steam-producers, I was, at the same time, aware that a report merely giving my own opinion, would not have the value that would attach to a report of systematic trials, of which the results could be stated in figures. Being aware that no experiments could be undertaken similar to those of the Admiralty and American navy trials, it became necessary to devise some plan by means of which the use of the necessary apparatus could be obtained without great expense. The proper method would have been, of course, the use of the same boiler for all coals, which boiler should be fitted with proper grates, flues, etc., for burning each coal in the most economical manner. As this would have entailed the erection of such an apparatus at the public expense, it appeared out of the question, and the only plan seemed to be to make such trials on locomotives and steamers as could be carried out with a small expenditure, through the liberality of the coal-owners, or other parties interested in knowing the true value of the coals.

Plan adopted for steam-trials.

Having obtained the consent of Sir William E. Logan, then Director of this Survey, I broached the subject to the agents of the several collieries which were in active operation, about the middle of the month of October

last, and, through their kindness, several trials were at once arranged for. Coal trials.
Through Mr. Jesse Hoyt, Manager of the Acadia Coal Company, I was permitted to make a trial of the Acadia steam-coal on the Provincial or Nova Scotia) Railway, by Mr. Lewis Carvell, General Superintendent of the railways of the provinces of Nova Scotia and New Brunswick, and many facilities were granted me by him, and all the other officials of the Railway Department.* At Mr. Carvell's request, another trial was made, shortly after, on the same railway, with wood, for a comparison of the two fuels.

Through Mr. Hoyt, and Mr. Hales, Manager of the Prince Edward Island Steam Navigation Company, a second trial of the Acadia coal was then made, on the steamer "St. Lawrence," of the P. E. I. Navigation Company's line. As before, I was granted every facility by all the officers of the line, and especially by Mr. Hales.

A third trial was that made with wood on the Provincial Railway, as Wood trial.
above referred to. This was undertaken at Mr. Carvell's request, in order to institute a comparison between wood and coal by practical experiment. By reference to that portion of this section headed 'Comparison of Coal and Wood,' it will be seen that the results were greatly in favour of coal.

Coal from the Acadia West colliery had been used on the Windsor branch of this railway, for some months, but, so far as I am aware, no train had been run over the main line from Pictou to Halifax with a coal-burning engine previous to my experimental train—the fuel hitherto used having been wood, furnished the railway by contract. I believe that the final result of my comparative experiments will be the complete abandonment of wood as a fuel on this railway, (so soon as the engines can be fitted for burning coal,) with very considerable saving in expense and time.†

The fourth trial was made on December 3rd., through the kindness of Mr. Dunn, Manager of the Intercolonial Coal Mining Company, on that Company's railway, with a Scotch coal-burning engine, and a loaded coal-train. In this experiment I was materially aided by Mr. William Crawford, C.E., the Company's Chief Engineer, who accompanied me on the engine, and noted the times of passing many points, by means of which a very complete record of the performance of the engine was obtained. A previous trial had been attempted on this railway, but it was stopped by stormy weather (rain and sleet), which prevented a proper adhesion of the driving-wheels to the rails. I ammuch indebted to Messrs. Dunn and Crawford for the facilities given me in these trials.

*I would especially acknowledge my obligations, for courtesies and information received, to Mr. Alex. MacNab, C. E., Chief Engineer of the Nova Scotia Railway.

† A detailed Report on these experiments will be made to Mr. Carvell, during the present season, by permission of the Director of this Survey.

Trials postponed.

A number of similar trials were planned for the middle of the month of December. Mr. Hudson, General Manager of the General Mining Association, placed the railway of that company, and a fine 26-ton English coal-burning engine at my disposal, for experiments on coals of the Main and Deep seams. Trips on the Association's steamer "Dragon," for a trial of Dalhousie-pit and Cage-pit coals, were arranged for, but continued stormy weather prevented these trials until it became necessary for me to return to Montreal, when it was decided to postpone them until the coming season, during which it is intended to complete the investigations.

In all of these experiments the greatest care was taken to burn the coals as economically as possible, and in notes of the performance of the engines and furnaces, the system of minute-blanks, first instituted, I believe by Messrs. Bunning and Richardson, in their experiments (at Devonport, and on the steamer "Weardale,") on North Country coals, was adopted. As my experiments are not yet complete, it is not deemed advisable to publish these notes in full, at present, and therefore, in the present Report, only an abstract of the principal facts of interest obtained, is given, the detail being reserved for future reports, when the series of trials for this region shall be completed.

To my own experiments on Acadia and Intercolonial coals, are added an abstract of the experiments on Albion-Mines coal, by Prof. W. R. Johnson, in 1843-1844, for the American Government; and a variety of statements concerning the value of the different coals of this region for gas-making and other purposes, which need not be here named in detail.

TRIAL No. 1, ACADIA STEAM COAL.

Railway trial of Acadia coal.

Date:—Nov. 3rd, 1869. On Nova Scotia Railway.
Trip:—From Pictou Landing to Richmond (Halifax).
Distance:—112 miles.

DETAILS OF EXPERIMENTAL TRAIN.

Locomotive used:—No. 7, N. S. Railway.

Description.—Coal-burner altered from wood-burner. Built 1857, by Neilson & Co., Glasgow. Tender-engine, four driving-wheels, 5′ in diameter; cylinders (2) 16½″ diameter × 21″ stroke. Has a rocking grate, (six bars 2′ 9″ long × 7 1/16″ wide;) hung with ½″ clearance, making grate 3′ 8″ wide, and giving about 10 square feet fire-surface. In each bar there are sixteen openings ½ 1/8″ × 7½″, which, with openings between bars, and at sides and ends, give about 8.5 square feet air-passage in grate. Grate is rocked by movable bar.

Experimental train.

Weight Train.	*Pounds.*
Engine.—The total weight of Engine No. 7, without tender is..... (Of this 35,650 lbs. is effective weight on drivers.)	66,130
Weight of tender, with water, without coal.....	40,340
1 supply platform-car, (coal); weight at start.....	35,380
3 box-cars, each carrying 100 barrels of flour.....	181,890

6 coal (platform) cars, (loaded)	205,090
1 first-class passenger-car	28,260
Officers and passengers	1,820
Total weight of train at start	558,910
Or about	249 tons, 10 cwt.

The length of this train, from front of leading-wheels of engine, (forward truck,) to rear wheel of last car, was 457 feet.

This train started from Pictou Landing at 10h. 23m. A.M., and with lengthy stoppages to pass up-trains, at several stations, arrived at Richmond station at 9.17 P.M. Trip.

The account of actual time and stoppages is as follows :—

	H. M.
Time of train on road	10.54
Length of stoppages	4.44½
Actual running time	6.09½

The character of the line run over, may be briefly described as being difficult for the first 39 miles, with up-grades as great as 67.58 feet to the mile ; easy, from 39 miles to 52 miles ; and with grades ranging from level to a rise of 50 feet to the mile, for the rest of the distance. The resistance encountered on these grades was materially increased by numerous curves, between Pictou Landing and Riversdale (39 miles), the sharpest of which was 955 feet radius ; and also by several sharp curves on the line between Windsor Junction and Richmond, the sharpest of which has a radius of only 792 feet. Line passed over.

During the trip, the coal had several severe tests as a steam-producer, as for instance between mile-posts 17 and 29, where the grades range from 51.90 to 67.58 feet per mile. These grades were ascended at an average speed of 10 to 13 miles per hour, and on the steepest, (Summit grade,) 67 feet per mile, with a curve of about 1000 feet radius, the engine kept up steam well, losing only 4½ lbs. in 6 minutes, with both pumps on ; * and making 59 revolutions per minute at the top of the grade.

The grate was shaken but three times ; at Glengarry (24 miles), Brookfield (60 miles), and Elmsdale (83 miles). No inconvenience was felt from ash, although the engine had a tight ash-pan, until Elmsdale was reached, when the throats of the dampers, forward and back, were found to be slightly choked with ash, and were cleaned, about 20 lbs. of ash being removed. The smoke-box was also opened, and about a bushel of cinders taken therefrom, which had covered a few of the lower tubes. With an

* Pumps of Engine No. 7, are two 2" plungers ; 21" stroke.

ordinary train, it is probable that neither of these cleanings would be needed, but this experimental train was, I believe, the heaviest ever run over the road.

STATEMENT OF COAL BURNT.

Coal consumed. The following is a statement of the amount of coal consumed on this trip:—

	Pounds.
Weight of supply car at Pictou Landing.....	35,280
" " Richmond	29,530
Coal put on tender.....	5,850
Deduct coal left on tender	214
	5,636

Or in round numbers 2 tons, 10 cwt. = 50.3 lbs. per train-mile, or 3.87 lbs. per car-mile.

Ash and clinker. The amount of ash and clinker from this coal was 552 lbs., or about 8.3 per cent. The ash was gray, with a reddish tint, the clinker brittle, with a flesh tint, in some places inclining to reddish. No clinker was observed adherent to the bars, and no pieces of clinker of a size exceeding three or four pounds.

Water evaporated. The water evaporated was estimated by carefully gauging the tank of the tender at each water-station, and calculating the weight of the number of cubic feet passed into the boiler, as given by the gauge-marks. Although liable to errors, it is probable, from the number of gaugings, that these errors will nearly balance one another, and that the general totals will be correct. The following is the calculated weight of water evaporated between stations:—

		Pounds.
Between Pictou Landing and Glengarry.	24 miles....	10,542
" Glengarry and Riversdale.....	15 "	4,869
" Riversdale and Pollybog.....	26 "	5,873
" Pollybog and Windsor Junction	35 "	10,291
" Junction and Richmond.....	12 "	3,137
Total, between Pictou and Richmond..		34,712

Result. This is equal to 6.159 pounds of water evaporated, to one pound of coal burnt. The average temperature of the feed-water, for the trip, was about 40° Fahrenheit, and the evaporative power of the coal for water from this temperature being equal to 6.159 lbs., its evaporative power in pounds of water from 212° F., would equal 7.24 lbs., to one of coal. *

* This result is obtained without taking pressures of steam into consideration, which would involve a lengthy discussion of varying pressures at different points on the road. It is only an approximation.

This result, which I consider remarkably good, was obtained, not from a picked sample of the coal, but from a fair average sample of the product of the colliery. The supply-car was taken as an average of a train of ten platform-cars of coal raised at the colliery on November 2nd, the day before the trial; the weight of coal on these cars being somewhat above 100 tons.

TRIAL NO. 2, ACADIA STEAM COAL.

Steamer-trial: Acadia coal.

Date:—November 5th, 1869.—On Prince Edward Island Steam Navigation Company's steamer "St. Lawrence."

Trip:—From Pictou Landing, Nova Scotia, to Charlottetown, Prince Edward Island.

Distance:—About 59 miles.

DETAILS OF STEAMER "ST. LAWRENCE."

Steamer "St. Lawrence."

This vessel is a side-wheel coast steamer, of the American pattern, with saloon and promenade decks above the hull. Her tonnage, according to her papers, is as follows:—

	Tons.
Tonnage under deck	382.61
" for propelling power	170.53
" houses, over deck	463.02
Gross tonnage	845.63

Her dimensions are:—

	Feet.
Length, total	201.5
Main breadth, (amidships)	30.2
Depth from deck	9.9

Her engine is a vertical-cylinder beam-engine of the American pattern. The details of engine, boiler, etc., are as follows:—

Machinery.

Engine.—Cylinder 44" by 11' stroke with Steven's cut-off; cutting off at 5½ feet (half stroke). (250 Nominal H. P.)

Boiler.—Compound boiler, (return flues and tubes). Breadth across three fires 13' 6"; length at furnace 8' 6"; cylindrical shell, 15' 6" long, and 11' 6" in diameter. The details of the flues are:—Outside furnaces, three flues, respectively, 10," 17", and 19" diameter; centre furnace, four 14" flues. Above these flues are 96 tubes, 17 feet long and 5" diameter.

Steam was up at the commencement of the trial, but before putting on any weighed coal the furnaces were cleaned of coal and ash, about 300 lbs. of fire being left for the start. At 11.30 A.M. 1200 lbs. of coal were put on to the fires, making in all 1500 lbs. put on before starting. The start at full speed was made at 12 h. 35 m. P.M., and the engines were then

run at regular speed during the entire trip to Charlottetown. The accompanying table shows all the detail of firing and performance of the engines, and gives almost all the information of value obtained during the trial. It shows the regularity with which the engines were run, and pressure of steam kept up with but little trouble on the part of the stoker. The reason that this table is given, is that in several published reports relating to Provincial coals, it has been stated that in using these coals a great amount of trouble is given to the fireman, through the coal clinkering and adhering to the bars, requiring perpetual raking and slicing to break up the fire in order to keep up a good draught. These statements are completely refuted by the notes given in the table, which shows that during the three hours commencing with 1, 2, and 3 o'clock, while the steamer was running regularly, no breaking up of the fire was needed; that the fires in all three furnaces were raked only four times, and that so far from the draught being obstructed, the fire-doors were frequently open for a number of minutes each hour, to admit air above the fires. The table is to be regarded simply as a transcript of the notes; and as no similar trials have yet been made with which the results might be compared, any farther discussion of these notes will be of no practical value.

Behaviour of coal under marine boilers.

Coal consumed.

The weight of coal consumed upon this trial was as follows:—

	Pounds.
Left on fires at start, about	300
Fires banked before starting, with	1,200
Actually consumed during trip	6,441
Total	7,941

of which 1326 lbs., or 16.69 per cent., was ash, clinker, and unburnt coal; the unburnt coal would probably equal about 100 lbs. No piece of clinker was observed of a size over four inches cube, and none adhered to the grate bars. The bars in the furnaces of the "St. Lawrence" had been in use for eight months, at the time of my trial, during which time Acadia coal has been burnt, and they showed no sign of fire-mark, and were every way in as good condition as when put in. I was informed by Mr. Turner, Chief Engineer of the P. E. I. Steam Navigation Company, that the bars in the "Princess of Wales," of the same line with the St. Lawrence, and also burning Acadia coal, had been in for some two seasons, (the running season being about eight months,) and that they were still in good condition. The importance of these facts will be appreciated by all engineers.

Grate

The officers of the steamer St. Lawrence, are: — Master, E. Evans; Chief Engineer, Jas. Turner; first assistant, Arch. Livingston; to all of whom I am indebted for their courtesies during my experiment. I was

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TRIAL No. 2, ACADIA ST

NOVEMBER 5TH, 1869

On Prince Edward Island Steam Navigation

TABLE SHOWING FIRING, AND PERFORM

Minutes after each hour.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Hour. Starboard furnace																																		F		F	
Centre "																																		F			
12 o'cl Port "																																		F			
Noon. No. revol. per minute																																			Start full speed.		14
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No. revol. per minute			16½							16½					16						16½					16½							16½			
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2 o'cl. Port "										F					16½																					
No. revol. per minute													27½													27½	15½					16				
Vacuum gauge, inches														16												16½					27½				
Steam " pounds																															16						
Starboard furnace				F										F																		F					
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3 o'cl. Port "																						F															
No. revol. per minute				16																	17														F		
Vacuum gauge, inches			27½																	27½												16		27½			
Steam " pounds			15½																	16½												16½					
Starboard furnace							F																														
Centre "			•	•	•	•							F		•	•	•							•	•	•	•			F				•	↑		
4 o'cl. Port "	F			•	•													F							•	•	•							•		F	
No. revol. per minute										16			16½									16								16½			R	S	F			15
Vacuum gauge, inches									27½											27½								27½					27½				27½
Steam " pounds									15½											16½						16½							16				15½
Starboard furnace			F				Soaking.							Stop Ch'tows.	Cleaning fires.	Pump started.																						
Centre "	F																																				
5 o'cl. Port "	R	F										S																									
No. revol. per minute			16		§	••	§	§	↑	↑	↑	↑	↑																								
Vacuum gauge, inches		27½			28																																
Steam " pounds	15½	15	15	15½	15½	....	16	16½	17	B	B	B	B	B																						

GENERAL NOTES AND REFERENCES.—The number heading the narrow columns indicates the minutes after the hour named in the first, (right) column. In each hour three lines are devoted to the fur
indicates *slicing*, or lifting the fire from the bars, and breaking it up with a slicer, and R indicates raking. The star (*) placed under a minute indicates that during that minute the fire-door of the furnace—
is placed under. The figures upon the three lines in each hour, marked "revolutions," "vacuum gauge," and "steam gauge" will be at once understood. They are placed in the minute column corresp

L No. 2, ACADIA STEAM COAL,

NOVEMBER 5TH, 1869,

TRIP FROM PICTOU LANDING, N. S., TO CHARLOTTETOWN, P. E. I.

STEAM NAVIGATION CO.'S STEAMER "ST. LAWRENCE."

G FIRING, AND PERFORMANCE OF THE ENGINES.

29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	Remarks.
					Start full speed.		F			S	S								•	•	•	•	•	•	•					•	•	Commenced firing at 11.30 A.M., the fires banked with 1500 lbs of coal.
		†	†	†				14½														16½						17				† Slow, turning engines by hand.
		23			27		27½				27½				27½						27½						27½					‡ Weather-barometer 29.05".
					15½		14½				14				15						16½						16					
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			F																			R	F		†							† Raking out ashes.
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	F				•	†	F					S	S			R	F	S			‡R					R							† Raking out ashes.
						•															‡R											‡ Preparing fires to enter Charlottetown.
	16½		R	S	F			15½			11								‡R		16½				R				F		15½	
			27½	27½				27½										27½							R							
			16					15½			15½							15½												27½			
																													15½			
																																Stopped at Charlottetown dock at 5.14 P.M.
																																½ Half speed. • • Full speed. † Turning engines by hand.
																																B. Blowing off steam.

each hour three lines are devoted to the furnaces. In these lines the letter F indicates that at the minute under which it stands, the starboard, centre, or port furnace, (as the case may be,) was *fired*. In the same way S g that minute the fire-door of the furnace—starboard, centre, or port, (as the case may be,) was left wide open; or ½ followed by the sign × that the door was one half open, continuing so, as many minutes as the sign × y are placed in the minute column corresponding to the moment of each observation. Other signs in the table are explained in the column headed "Remarks," on the same horizontal line in which each sign occurs.

assisted by Mr. Thos. Lawther, of the Albion Mines, who took notes in the fire-room, of the firing and weight of coal used.

Beside the notes given in the table, minute-notes were taken, during several hours, of the smoke emitted from the funnel of the steamer, from which the smoke-equivalent of the Acadia coal, as burnt in the furnaces of the St. Lawrence, appears to be about 120; showing that the coal is not burnt by any means as economically as is possible.* Smoke.

It was first my intention to include the notes of the smoke, or *smoke-marks*, in the table of firings, but as the notes were taken by a person with but little experience in this matter, I reserve them for a future report, if corroborated by subsequent experiments.

TRIAL No. 8 WOOD.

(FOR COMPARISON WITH ACADIA STEAM COAL.)

Date:—Nov. 10th, 1869. On Nova Scotia Railway. Railway trial of wood.
Trip:—From Pictou Landing to Richmond (Halifax).
Distance:—112 miles.

DETAILS OF EXPERIMENTAL TRAIN.

Locomotive used:—No. 19, N. S. Railway.

Description:—Wood burner by Neilson & Co., Glasgow. This engine is of the same pattern and dimensions as No. 7, and before the alterations in furnace and draught arrangements of No. 7, the two engines were precisely similar. This engine was not weighed, but the weight may be safely taken as the same as that of No. 7.

		Pounds.	
Weight of Train.—	Weight of engine without tender	66,130	Experimental train.
	Weight of tender with water, (without fuel)	40,340	
	5 box-cars, each carrying 100 barrels of flour	181,040	
	7 coal (platform) cars, (loaded)	229,670	
	1 first-class passenger car (same as No. 1 Trial)	28,260	
	Officers and passengers	1,820	
	Total weight of train, not including wood on tender, which amounted to 1¼ cords, or about 3 tons, 3 cwt., at start	547,260	
	Or about	244 tons, 7 cwt.	
"	Add fuel, at start	3 " 3 "	
"	Total weight with fuel about	247 " 10 "	

*For discussions of the subject of the economical use of bituminous coals as steam-producers, see the Reports of Messrs. Richardson and Bunning, "On the experiments at Keyham, on the use of mixed Hartley (Newcastle) and Welsh coals in Marine boilers," Trans. North of England Institute of Mining Engineers, Vol. XIV; — the "Report of a Committee on the Smoke Question," Ibid., Vol. XVIII, p. 37 et seq.; and Mr. Bunning's Report on Experiments on Hartley coal, on the steamer Weardale, Ibid. Vol. XVIII, p. 105. These experiments will be again referred to, and some notes on this subject given, in the latter portion of this Section of this Report.

Or only about two tons less than the train in Trial No. 1. The length of train was, as before, 457 feet, the same number of cars of each class being used.

Trip.

This train started from Pictou Landing, at 8 h. 34 m. A.M., and after many stoppages, as before, to pass up-trains, and to allow regular down-trains to pass, reached Richmond station at 9. h. 18½ m., P.M.

The account of actual time and stoppages is as follows :—

	H.	M.
Time of train on road	12.	44½
Length of stoppages	5.	55½
Actual running time	6.	48½

The character of the line has already been described, under Trial No. 1, and the conditions of weather, track, etc., under which the two trials were made were as nearly as possible similar. Steam was kept up well by the engine, but with much greater labour of the fireman than during the previous trial. It is difficult to make a proper comparison between the two experiments in this particular, without a table showing the varying pressures on the different grades throughout the entire length of the line. Such a tabulation has been made in manuscript, but will not be here given, as it would necessarily extend the size of this Report. It shows no important difference between coal and wood. It has already been noted that on the Summit grade (67.58 feet to the mile, with a curve of about 1000 feet radius), the engine in the coal-trial made 59 revolutions per minute, with both pumps on. Under precisely similar conditions, the wood-engine, with a train of about two tons less weight, made 47 revolutions. Thus, in the severest test during the experiments, the coal gave the best result.

With wood, as may be expected, no attention to ash or cinder was necessary.

STATEMENT OF WOOD BURNT.

Wood consumed.

The following is a statement of the wood taken on to the tender during the trip :—

Wood taken on at Pictou Landing	1½	Cords.
" " " " Glengarry, 24 miles	¾	"
" " " " Riversdale, 38 "	¾	"
" " " " Pollybog, 64 "	¼	"
" " " " Windsor Junction, 99 "	¼	"
Total taken on to tender during trip	4	Cords.
Remaining on tender at Richmond	¼	"
Total wood consumed on trip	3¾	Cords.

This wood (dry), weighs about 2 tons 1 cwt. per cord ; the total quantity consumed would thus amount to about 17.210 lbs., equalling 7 tons 14 cwt., nearly. This is equal to 153.66 lbs., per train-mile, or 11.88 lbs. per car-mile.

Water evaporated.

The weight of water evaporated was estimated as in the previous railway trial. The calculated amounts used between stations are :—

		Pounds.
Between Pictou Landing and New Glasgow,	8 miles.	2,761
New Glasgow and Glengarry	16 "	7,831
Glengarry and Riversdale	15 "	5,175
Riversdale and Pollybog	26 "	7,530
Pollybog and Elmsdale	18 "	5,330
Elmsdale and Windsor Junction	17 "	6,024
Junction and Richmond	12 "	2,886
Total between Pictou and Richmond		37,537

Results.

This is equal to 2.181 pounds water evaporated for one pound of wood burnt, the temperature of the feed-water being, as before, about 40° Fahrenheit. The quality of the wood used on this trial, was, in my opinion, considerably better than the average supplied to the railway ; at least in a number of trips between Pictou and Halifax, I have never seen as good quality used ; it was principally hard-wood, birch, etc.

COMPARISON OF COAL AND WOOD.

(DEDUCED FROM TRIALS OF ACADIA COAL AND WOOD, ON THE N. S. RAILWAY.)

Comparison coal and wood.

In regard to length of trip, condition of track, and weight of train, the comparative trials may be said to have been made under nearly similar circumstances. The weight of train in the wood-trial was two tons less at the start than the train in the coal trial, but the amount of wood added during the wood-trial at different points, and carried varying distances, probably equalled two tons carried the entire distance. The length of stoppages during the wood-trial was 1h. 1½m. longer than in the coal experiment, which would result, though to only a small extent, in favour of coal. All things considered, however, the conditions in each were practically the same, and it now only remains to compare the results, in the most important particulars of time, labour of men, first cost and expense in use of the two fuels.

Time.

Time.—It has been remarked on the preceding page that no important difference has been shown by the notes taken of the steam-gauge during the two trials. That there must be some difference in favour of coal, in capacity for keeping steam, will be seen by a comparison of actual running time, which stands as follows :—

	H.	M.
Actual running time, wood trial	6	48¼
" " coal trial	6	09¼
Difference in favour of coal	0	39

A saving of time might be effected if coal were used, from the fact that enough coal might be put on to the tender at the start from either terminus of the railway, for the entire trip. This could not be done in using wood, for several reasons:—first, because the capacity of the tender would not be sufficiently great; and second, even if the tender were of sufficient capacity, the great weight carried, (7 or 8 tons of wood, to say nothing of the greatly increased weight of tender,) would be a material objection.

Time lost in wooding-up.

In the first of the experiments under consideration, the greater part of the coal consumed was put on the tender at Pictou Landing, a small portion being added from the supply-car during the last 25 miles. As the entire quantity *might* have been added, without inconvenience, at the start, we may assume that no time was lost in coaling.

During the second trial, the record of time consumed in *wooding-up* stands as follows:—

At Glengarry	3 men employed in wooding	9	minutes.
" Riverdale	3 " "	7	"
" Pollybog	2 " "	6	"
" Windsor Junction	3 " "	5	"
Total time employed in wooding		27	minutes.

As it was generally known along the line that this train was an experimental one, it is but reasonable to suppose that, at least, the usual celerity in wooding was attained. The account includes only the actual time employed in throwing the wood on to the tender. Probably several minutes might be added for time consumed in getting the train in position at the wooding-station, starting, etc. If we suppose this extra time to amount to three minutes, we then have one half hour of time lost in taking in wood, between Pictou and Halifax.

Labour.

Labour of men.—It will be evident from the last paragraph that a considerable amount of labour would be saved at the various stations were all the fuel for a trip carried from each terminus. This, however, properly comes under the head of expenses, and the only point to be here considered is the difference in labour of the fireman, which is very considerable, as will be seen by a comparison of the two fuels burnt:—coal, 5,636 lbs.; wood, about 17,210 lbs.; divided into, respectively, 76 and 136 firings.

Comparative expense.

Comparative expense.—Not being connected with this railway, I have no means of estimating, except in the rudest manner, the comparative

expense in the use of the two fuels. An approximate idea can be gained by a moment's consideration of the general management required to supply trains at the termini, and at various points along the road.

Wood.—After being cut, the wood is generally corded at or near some point on the main line, from whence it is taken on extra wood-trains to the different wooding-stations, to be used as need be. This not only requires many extra hands, but extra trains, with consequent wear and tear of rolling-stock and permanent way.

Coal.—With coal, but two coaling-stations would be required; at Pictou and Richmond (Halifax). The coal could be put into coal-cars at the mines, for transportation to the two termini, or, should a third station be required, to Truro also. At these stations a system of shutes could be arranged, by means of which the coal could be put into the tender very quickly, and without any handling. I shall not attempt to estimate the cost of running the line, but for general information it may be stated that the cost of coal, delivered at Coal Mines station, is about $2.25 per ton, (or, say $2.50 at Pictou Landing, and $3.00, without profit in carriage, at Halifax;) while the contract price of wood is, I believe, $3.50 per cord, delivered at the wooding stations. During about eight months in the year two regular passenger and freight trains are run each way per day, on this railway, between Pictou and Halifax, and two each way between Truro and Halifax (61 miles); to say nothing of the extra and coal trains. During the winter months, only one through-train is run, each way, per day.

TRIAL NO. 4; DRUMMOND COAL.

Drummond coal trial.

This trial was made on December 2nd, 1869; a previous trial, in the latter part of the month of November, having been abandoned on account of bad weather. The length of the Intercolonial Coal Mining Company's railway (about 6¾ miles) not being sufficient for a proper trial with a single trip; three round trips (from the colliery to the Drummond wharf at Granton, and back—13½ miles) were made with a loaded coal train. During these trials the usual careful notes were taken of the performance of the engine, and the line being staked out in miles and half-miles, the time of passing the stakes, as well as a number of other points on the road, were also taken, to a second, by Mr. William Crawford, C.E., Chief Engineer of the Intercolonial Company, who kindly accompanied me, and to whom I would express my obligations for the interest he has taken in my experiments, and the valuable aid he has afforded me.

The notes of this trial furnish a complete record of the performance of the engine upon each grade, and when time permits they will be given to the public, with a proper discussion of the facts elicited.

For the purpose of the present Report, however, it will be sufficient to

give the general results, and the trial will be divided into two experiments; the first, (experiment A), from an improper arrangement of the ash-pan and grate-bars, not having been as successful as the second (experiment B). The same train was used in both.

Intercolonial Coal Company's railway.

Description of line.—The down-trip from the colliery to Granton was comparatively easy, as it included only about one and a-half miles of up-grade, ranging from 44 feet to 53½ feet per mile. The average grade on the return-trip was about 50 feet up, per mile, for the first three miles; down about 45 feet per mile, for one and a-half miles, and then up, with grades ranging from 23½ feet to 98 feet per mile, and averaging, perhaps 65 feet per mile. Some of the curves were very sharp; one of 600 feet radius, and one more than one-quarter of a mile long of 655 feet radius, besides a number ranging from 702 feet to 1,433 feet radius.

DETAILS OF TRAIN IN BOTH EXPERIMENTS.

Locomotive used :—No. 3, Intercolonial Coal Mining Company's Railway.

Description :—Coal burner by Dübs & Co., Glasgow, Scotland—Tank-engine, six drivers, 5' diameter (coupled). Cylinders (2) 14" diameter × 22" stroke,—with 75 per. cent. of steam on piston when in full gear. Firegrate area 12.12 square feet. 152 brass tubes, 1¾" outside diameter—superficial area of which is 680.48 square feet. Wheel-base of engine, 11 feet.

Experimental train.

Weight of Train.—

	Tons.	cwt.
Weight of engine No. 3, empty	20	0
Equipment	5	0
12 coal cars, loaded, (75 tons coal)	116	17
Officers and passengers	0	7
Total weight of train	142	4

The length of this train from tread of forward driver was 196 feet.

The coal consumed was carefully weighed on a Fairbanks scale, and the water evaporated estimated as in previous trials. The two tanks of the engine were rectangular, and being exactly filled each time of taking-in water, the estimate of water may be relied upon.

EXPERIMENT A.

First trial.

In this experiment the grate-bars in the furnace of Engine No. 3 were not properly arranged, every other grate-bar having been removed, leaving about 2 inches between the bars, through which a considerable amount of unburnt coal fell, choking up the dampers of the ash-pan (which was very small), and thereby obstructing the draught. Added to this, the day was so intensely cold that the steam-gauge was frozen on the up-trip, and the

fires could not be properly regulated. The record of distance, time, etc., is as follows :—

Distance.

Trip 1. Down to wharf at Granton.....distance	6.60 miles.	
" 2. Back to upper siding at colliery ..... "	6.84 "	
Total distance; round trip.....	13.44 miles.	

Time.

	Min.	Sec.
Trip 1. Time on road, no stoppage.....	24	46
" 2. " " " 52 m. 20 s. stoppage 18 m., actual time...	34	20
Actual running time (13.44 miles)	59	06

During experiment A, trip No. 2, the steam-gauge was frozen, and the fire could not be properly managed ; the 18 minutes stoppage was time lost in thawing the gauge, and getting up steam with the blower, while standing.

STATEMENT OF COAL BURNT AND WATER EVAPORATED.

Results.

The amount of coal burnt, while running and during stoppage, was 658 lbs ; the water evaporated being 3,423 lbs. This is equal to 5.202 lbs. of water, evaporated from the temperature of the feed water, (about 35° F.), to the pound of coal consumed, or 6.15 lbs. of water evaporated from 212°, to one pound of coal, not taking pressures of steam into consideration. The coal was divided into 12 firings ; 3 on the down-trip and 9 on return-trip to the colliery. The fire-door was open 9 minutes on the down-trip and 7 minutes on the return. The engine was on a down grade 18 minutes, during the down trip (and not using steam), and about 4 minutes during the return. The fire was broken up with the pricking-bar, once on each trip, which was all the attention it required, save firing. The coal steamed well, except at the close of the second trip, when the ash-pan damper became choked with ash and unburnt coal, (the engine being designed for Scotch coal, which gives very little ash.)

EXPERIMENT B.

Second trial.

This trial was far more successful than the first, as the full set of bars were put in, leaving spaces of but $\frac{3}{4}$ of an inch between them. The ash-pan was removed, and the steam-gauge properly protected. Four trips (or two round trips) were made with the same train as in experiment A. The record of distance, time, etc., is as follows :—

Distance

Trip 3. Colliery to wharf.....distance	6.65 miles.	
" 4. Wharf to upper siding at colliery..... "	6.80 "	
" 5. Upper siding to points near wharf..... "	6.62 "	
" 6. Wharf to upper siding at colliery..... "	6.74 "	
Total distance; four trips.....	26.81 miles.	

Time.

								H.	Min.	Sec.
Trip 3.	Time on road	27m. 40s.,	stoppage	4m. 15s.,	actual time			0	23	25
" 4.	" "	35m. 00s.,	"	7m. 38s..	"	"		0	27	22
" 5.	" "	21m. 05s.,	no stoppage		"	"		0	21	05
" 6.	" "	41m. 25s.,	stoppage 8m. 10s.,		"	"		0	33	15
Actual running time, (26¼ miles)								1	45	07

STATEMENT OF COAL BURNT AND WATER EVAPORATED.

Results.

Steam being up at the commencement of this experiment, the amount of coal consumed was 1,236 lbs., during the four trips. The amount of water evaporated was 8,253 lbs.; thus the result was:—6.67 lbs. of water evaporated from 35° F., by one pound of coal, equal to 7.69 lbs. evaporated from 212°, without taking steam-pressures into consideration. This result not only proves the coal to be an excellent steam-coal for locomotive use, but also indicates that the coal was very economically burnt by the locomotive. In comparing this result with the results of railway trial No. 1, of Acadia coal, the fact should be taken into consideration that the result in the Drummond coal-trial was obtained with an engine built expressly for burning this class of bituminous coals, whereas the engine used in the Acadia steam-coal trial was a wood-burner, but slightly altered, and in all probability not burning the coal in the most economical manner.

The notes of the second experiment (B) give the following facts, which are, perhaps, worthy to be included here:—During the four trips, the number of firings was 17; the fire-door was open for draught above the grate, 62 minutes; and the engine was on an up-grade—or using steam—during 81 minutes.

Ash of coal

The ash from the coal burnt was gray, with a faint reddish tinge. The coal clinkered somewhat, but no inconvenience was felt from that cause, as the clinker did not adhere to the grate bars.

Portion of seam used.

The coal used was believed to be a fair average of the 16 feet of the seam worked; being a mixture of all the benches except the *top-coal* and *coarse-coal* at the bottom of the seam.

AMERICAN NAVY TRIALS OF PICTOU COALS.

American coal-trials by Prof. Johnson.

In a very complete series of trials undertaken for the American government by Professor W. R. Johnson, in 1843 and 1844, were included experiments on two samples of Pictou coals, both from the Old Albion mines, and taken, I believe, from the upper twelve feet of the Main seam. These experiments were conducted with the greatest care, and with the exception of the British experiments, made by Sir Henry T. De la Beche and Dr. Lyon Playfair, for the Lords Commissioners of the Admiralty, the

American trials are probably the most complete and accurate series of trials of steam-coals ever made.

Report of Prof. Johnson.

As the results of Professor Johnson are of great value to the consumers of Pictou coals, I shall take the liberty of including an abstract of them in this Report, especially as the volume in which they are contained ("Report to the Navy Department of the United States on American coals applicable to Steam Navigation, etc.," by Walter R. Johnson,) has been for years out of print.

Apparatus employed.

The boiler employed in these experiments was 30 feet long and 3½ feet in diameter; set over a furnace, and the heated gases after passing from the fire through two interior return-flues, each of 10 inches interior diameter, escaped either through an opening, known in the Report as the *lower damper*, into the chimney, or when this damper was closed, it ascended from the ends of the two return-flues into an exterior flue on the *left* of the boiler, and passed along this once more to the rear of the boiler, crossed the end, and entered a *right hand* exterior flue, by which, through the *upper damper*, it arrived at its exit into the chimney, entering the latter at a level only 14 inches higher than when it passed by the direct exit-flue to the lower damper. The details of heating-surface, and lengths of flues traversed, together with the arrangements for heating the air before passing through the grate, are given in the following quotation from Professor Johnson's report. It follows the detailed description of the boiler and flues, a partial abstract of which I have just given:—

Draught arrangements.

"From this description, it will be observed that the air which supplies the combustion, passes first into a chamber beneath the ash-pit, about 7 feet long, and 3 feet 3 inches wide, along the sides of which are several openings, by which it finds its way into the two longitudinal side chambers, 30 feet long, 6 feet high, and 9 inches wide, between the two side walls; and having arrived, by these, at the rear of the boiler, passes 25 feet beneath the flue, arriving at the *centre* of the grate after a course of 60.5 feet. Thence a course of 58.5 feet brings the products of combustion to the aperture through the passage, by the lower damper, into the chimney; and of 62.5 feet farther, or 121 feet from the centre of the grate, to the point where they finally quit the boiler by the exterior flue. The part of the lower arch of the boiler, exposed to the action of heat, is 130 square feet, and that of the two return-flues is 157 square feet; so that when the combustion was conducted by allowing the products to make their exit through the lower passage, or after passing twice the length of the boiler, the heated surface was 287 square feet. The boiler-surface exposed in the exterior flue, or second circuit, is 90.5 feet; making the entire surface, when the products traversed four times the length of the boiler, 377.5 square feet. The grate being 5 feet long, and 3 feet 3 inches wide, when

Surfaces.

Grate.

at its full dimensions, its area was 16.25 square feet; and the ratio of the grate surface to the heated surface, when the combustion was carried on through the lower damper, was 1 : 17.66; when through the upper damper, making the circuit 121 feet long, this ratio was 1 : 23.23.

Air-plate bridge.

"When the air-plate bridge was introduced, it covered 8 inches of the length of the grate, reducing its area to 14.07 square feet, and increasing the ratio of heated to grate surface to $\frac{377\frac{3}{4}}{14.07} = 26.83$ to 1.

"During a few trials the grate was still farther reduced in area, by the introduction at the front end, next to the fire-doors, of a plate of iron 3 feet 3 inches long, 11¾ inches wide, and one-fourth of an inch thick. This

Coking-plate.

is termed the "*coking-plate*," and was used while burning some of the samples of bituminous coal, which were so fine that large portions were liable to pass through the grate. With this plate in place, and the air-plate in its usual position, the size of the grate was reduced to 11.375 square feet, and the heated to the grate surface increased to $\frac{377\frac{3}{4}}{11.375} = 33.18$ to 1.

"On one occasion, instead of contracting the area of the grate by means of the coking plate, it was diminished by placing a row of bricks flatwise along each side of the furnace, reducing the grate surface to 10.291 square feet, and the ratio of *heated* to *grate* surface to $\frac{377\frac{3}{4}}{10.291} = 36.68$ to 1.

Depth of fire.

"The grate was, in general, about 9 inches at the front, and 10 inches at the back end, below the lower arch of the boiler. On one or two occasions, however, which are noted in the tables of experiments, it was varied a little from this distance; but as no advantage appeared to attend the change, it was restored to this, as the most convenient working distance for all the varieties of fuel employed.

Grate-bars.

"The grate-bars used were three-fourths of an inch thick, and the spaces between them half an inch wide. They were supported at the centre, as well as at each end, by a cast-iron bar 2½ inches thick, and 4 inches deep. Hence, when the grate was at its full size, the total amount of air passages through the grate was nearly 5⅛ square feet.

Capacity of boiler.

"The interior capacity of the boiler was such as to contain, when filled to the centre of the gauge-tube, or *normal* level of the experiments, with water of 66° temperature, 12,795 lbs. This is the result of an experiment made after clearing out and wiping dry the interior of the boiler, and refilling it through the measuring-cistern. Of this quantity, 493 pounds were then withdrawn, leaving 12,302 pounds, filling the boiler to within 1.1 inch of the normal level. On subsequently heating this to 230°, the water in the gauge, after taking all due precaution to withdraw the cold water from the glass tube, and filling it with that which was hot, stood once more at the normal level. Hence the apparent expansion of water in iron, by an addition of 164 degrees of heat, is equivalent to $\frac{1}{12}\frac{3}{5}\frac{3}{0}\frac{3}{7} = 0.0407$, or a little more than one twenty-fifth part of its bulk at 66 ."*

* Report on American Coals, pp. 12-13.

The details of supply of water, gauges and discussions of the method of conducting the experiments, though of very great scientific interest, occupy too much space to be given here. I shall therefore proceed to the results of the experiments, using as nearly as possible the arrangement of the original report. All the facts which follow, are taken from Johnson, and where advisable, his report is quoted *verbatim*.

Other details omitted.

Under Class IV, (p. 452) of the Report, Professor Johnson includes: "Foreign bituminous coals, and those of similar constitution West of the Alleghany Mountains." Among the foreign coals, he includes:—

Classification of Pictou coals.

1. Pictou, (purchased in New York.)
2. Sydney.
3. Pictou, (Cunard's.)
4. Liverpool.
5. Newcastle.
6. Scotch.

Johnson's Class IV.

In description of the general characters of these coals, he says:—"In many respects this class of coals bears a strong analogy to the preceding.* The ratio of the fixed to the volatile combustible matter is, however, something less. The exterior presents often a resinous lustre. The surfaces of deposition are easily developed by fracture. Great facility of ignition and a high degree of activity in the combustion of their volatile constituents, are also general properties of this class. Their high proportion of volatile combustible matter renders these coals, when nearly free from sulphur, eminently suitable for the production of illuminating gas; and the tendency of their cokes, with few exceptions, to intumesce strongly, renders them, in common with the preceding class, highly serviceable for forming large hollow fires for smithing purposes."

General characters.

(*Copy.*)

No. 1.

Bituminous coal from Pictou, Nova Scotia, procured from Messrs. Laing & Randolph, in New [illegible], for comparative experiments.

This coal has a glimmering lustre, or a dull aspect, according to the part observed. The surfaces of deposition are, in some specimens, inclined at an angle of 83° to the main partings; thin scales of earthy matter are occasionally found in the joints, or vertical seams; but, in general, little impurity is observable on the exterior. Conchoidal fractures are of unfrequent occurrence. The coal was of average size, lumps and fine being intermixed in due proportion, to constitute a merchantable article for ordinary use in smith's fires, and for domestic purposes. The

Trial of the coal bought in New York.

* Class III. Bituminous coking coals from the eastern coal-fields of Virginia in the neighbourhood of Richmond. (Report, pp. 308-541.)

powder of this coal is of a dark brown colour, and its streak on a white earthern ground is of the same tint.

The specific gravity of one specimen (*a*) was 1.3546; that of another, (*b*) 1.2807: from the mean of which, the calculated weight per cubic foot is 82.35 pounds.

By 39 trials in the charge-box, the greatest weight of any one charge was 112.25 pounds, or 56.125 lbs. per cubic foot. The least weight was 97.5 lbs. per charge, or 48.75 lbs. per cubic foot; while the average of the whole was 53.548, or 0.6502 of the above calculated weight. The space for the stowage of one ton of the coal is 41.832 cubic feet.

The moisture in specimen *a* was 0.97; and that in *b*, 0.935 per cent.

The volatile matter, other than moisture, in *a*, was 27.51; the sulphur, 0.7689 per cent.

The volatile matter, other than moisture in *b*, 20.105.

Four incinerations of *a*, gave of *ashes* 2.38; and the same number of *b*, 2.65 per cent. Hence the composition is as follows, viz:—

Analysis.

	Specimen *a*.	Specimen *b*.
Moisture	0.970	0.935
Sulphur	0.769	(not tried.)
Other volatile matter	26.741	20.105
Earthy matter	2.380	2.650
Fixed carbon	69.140	76.310
	100.	100.
The volatile to fixed combustible	1 : 2.5132	1 : 3.7955

Two specimens of this sample of coal were assayed by Dr. King, and yielded, the one 36, and the other 33, per cent. of volatile matter, including moisture. These, combined with the above, give a mean of 29.63, which may probably be assumed as a pretty near approximation to the average yield of this ingredient.

By exposure for four days in the steam-drying apparatus, 28 pounds of this coal lost 0.71875 lbs. of moisture, or 2.567 per cent.

During the four trials of evaporative power, 4153.875 pounds were burned, and yielded 302.4 lbs. of ashes, (including those of 408.62 lbs. of pine wood,) 253.475 pounds of clinker, and 19.5 pounds of soot. The ashes lost by re-incineration 5.907, and the soot 65.42, per cent. of their weight.

Hence the absolutely incombustible materials are—

From the ashes	284.540 pounds.
" clinker	253.475
" soot	6.743 "
Total	544.758 "
Deduct for wood ashes	1.227 "
Leaves	543.531 "

which is 13.389 per cent. of the coal burned.

By these data we may assign the following as the proximate constituents of this sample, viz. :— Practical analysis.

Moisture, (from 28 lbs.)	2.567	per cent.
Other volatile matter, (mean of 4 specimens)	27.063	"
Earthy matter (from 4153.87 lbs.)	13.389	"
Fixed carbon	56.981	"
	100.	
Volatile to fixed combustible	1 : 2.1054	

The above result in earthy matter, derived from a sample of two tons, exhibits a striking contrast with the analyses of single hand-specimens.

The clinker is of a dark reddish-brown colour, in sheets of considerable magnitude, somewhat porous; small shaly fragments are intermixed, and sometimes adhere to the vitrified masses. It weighed 43.12 pounds per cubic foot, and gained weight by calcination equal to 0.84 per cent., leaving the powder of a light brown, with its finer parts bright red. Clinker.

The weight of the ashes, as they came from the furnace, was 38.56 lbs. per cubic foot; and the residue of their re-incineration had a colour nearly flesh-red, while that from the soot was reddish-grey—a shade lighter than that from the ashes. Ash.

The ashes from specimens *a* and *b* are of a purplish-red colour, with specks of white.

Tried with the oxide of lead, 20 grains of specimen *a* gave 544.8 grains of metallic lead, or 27.24 times its weight. Deducting moisture and earthy matter, this gives to one of combustible matter 28.184.

In a smith's fire for ordinary work, this coal afforded a rather dull combustion; made a good hollow fire; left a fair coke, not unusually hard; produced a large quantity of cinder, and gave a tolerably fair heat.

In the chain-shop, it gave a heavy flame; formed a coke too hard to be easily broken up, as the work requires; was rather hard and unmanageable, and left a large proportion of cinder. Sixty pounds made but 11 links of a chain $1\frac{3}{8}$ inch in diameter; while several other coals, tried by the same workman on the same chain, were found adequate to the making of from 13 to 20 links, by the same weight of coal. Trial for chain making.

* * * * * * * *

The ignition of this coal is easily effected. It took, on an average of four trials, only 0.937 hour, or $56\frac{1}{4}$ minutes, to bring the boiler to a state of steady action. In conformity with this fact, is that relative to the unburnt coke, which was, on an average, only 5.689 lbs. at each trial.*

* Here follow tables giving the details of all the experiments; from which the deductions in the table on the next two pages are taken. It is extracted *verbatim* from Johnson's Report.

DEDUCTIONS FROM TABLES CLV, CLVI, CLVII.

Experiments on Pictou

		Nature of the data furnished by the respective tables.	1st Trial. (*Table CLV.*)	2d Trial. (*Table CLVI.*)
			August 30.	*August* 31.
Results of Trial No. 1, Class IV.	1	Total duration of the experiment, in hours	23.033	23.95
	2	Duration of steady action, in hours	6.333	6.333
	3	Area of grate, in square feet	14.07	14.07
	4	Area of heated surface of boiler, in square feet	377.5	377.5
	5	Area of boiler exposed to direct radiation, in square feet.	18.75	18.75
	6	Number of charges of coal supplied to grate	9.0	10.0
	7	Total weight of coal supplied to grate, in pounds	978.50	1071.75
	8	Pounds of coal actually consumed	974.88	1069.612
	9	Pounds of coal withdrawn and separated after trial	3.62	2.138
	10	Mean weight, in pounds, of one cubic foot of coal	54.301	53.5875
	11	Pounds of coal supplied per hour, during steady action.	120.77	119 69
	12	Pounds of coal per square foot of grate surface, per hour.	8.583	8.506
	13	Total waste, ashes and clinker, from 100 pounds of coal.	13.714	12.934
	14	Pounds of clinker alone, from 100 pounds of coal	6.6911	6.2139
	15	Ratio of clinker to the total waste, per cent	48.788	48.0095
	16	Total pounds of water supplied to the boiler	7759.0	8340.0
	17	Mean temperature of water, in degrees Fahrenheit	82°.8	83°.0
	18	Pounds of water supplied at the end of experiment, to restore level	782.0	550.0
	19	Deduction for temperature of water supplied at the end of experiment, in pounds	99.0	69.0
	20	Pounds of water evaporated p. hour, during steady action	882.36	908.88
	21	Cubic feet of water per hour, during steady action	14.12	14.54
	22	Pounds of water per square foot of heated surface per hour, by one calculation	2.337	2.407
	23	Pounds of water per square foot, by a mean of several observations	2.347	2.397
	24	Water evaporated by 1 of coal, from initial temp. (a) final result	7.868	7.783
	25	Water evaporated by 1 of coal, from initial temp. (b) during steady action	7.301	7.5936
	26	Pounds of fuel evaporating one cubic foot of water	7.9537	8.0823
	27	Mean temperature of air entering below ash-pit, during steady pressure	92°.59	92°.31
	28	Mean temp. of wet-bulb thermo., during steady pressure	79°.08	80°.69
	29	Mean temperature of air, on arriving at the grate	254°.92	259°.125
	30	Mean temp. of gases, when arriving at the chimney	301°.25	334°.6
	31	Mean temperature of steam in the boiler	229°.54	229°.5
	32	Mean temperature of attached thermometer	84°.88	86.94
	33	Mean height of barometer, in inches	30.161	30.079
	34	Mean number of volumes of air in manometer	5.225	5.210
	35	Mean height of mercury in manometer, in atmospheres.	0.5342	0.5366
	36	Mean height of water in syphon draught-gauge, in inches	0.2907	0.3077
	37	Mean temperature of dew-point, by calculation	75°.9	77°.525
	38	Mean gain of temp. by the air, before reaching grate	162° 61	166°.535
	39	Mean difference between steam and escaping gases	71°.71	105°.1
	40	Water to 1 of coal, corrected for temperature of water in cistern	7.8258	7.7013
	41	Water to 1 of coal, from 212°, corrected for temperature of water in cistern	8.8059	8.6658
	42	Pounds of water, from 212°, to 1 cubic foot of coal	478.74	464.38
	43	Water, from 212°, to 1 pound of combustible matter of the fuel	10.2055	9.9532
	44	Mean pressure, in atmospheres, above a vacuum	1.4213	1.4288
	45	Mean pressure, in pounds p. sq. inch, above atmosphere	6.2219	6.3324
	46	Condition of the air-plates, at the furnace-bridge	Open.	Closed.
	47	Inches opening of damper, (U. upper)	U. 8	U. 8.

CLVIII, OF JOHNSON'S REPORT, PAGES 456-463.

coal (from New York.)

3rd Trial. (*Table CLVII.*)	4th Trial. (*Table CLVIII.*)	Averages.	Remarks.
September 1.	*September* 2.		
23.05	23.05		
10.00	7.083		
14.07	14.07		
377.5	377.5		
18.75	18.75		
11.0	9.0		
1179.5	947.0		
1166.61	942.89		
12.89	4.11	5.6895	
53.614	52.611	53.5434	
96.9	104.01	110.342	
6.887	7 392	7.842	
13.195	13.842	13.3712	
5.2321	6.3657	6.1257	
39.651	46.658	45.7916	
8743.0	6661.0		
84°.1	82°.7		
575.0	547.0		
72.0	69.0		
721.9	684.59	799.432	
11.55	10.953	12.7908	
1.912	1.813	2.1172	
1.893	1.794		
7.432	7.009	7.508	With damper drawn 8 inches, the first trial gave, with a clean surface of boiler and flues, and the air-plate open, 7.858 of water to 1 of coal; the second, with the same plate closed, and surfaces with one day's impurity on the flues, 7.733, or 1.6 per cent. less.
7.449	6.5802	7.231	
8.4096	8.9171	8.3407	
89°.8	90°.33		
79°.21	78°.87		
282°.05	278°.8	268°.724	
315°.42	306°.71	308°.702	
231°.0	228°.6		
85°.71	83°.0		
30.080	30.104		
5.227	5.247		
0.5343	0.5323		
0.2845	0.2443	0.2818	
75°.53	75°.7		
191°.72	189°.0	177°.466	
85°.33	77°.77	84°.89	
7.4009	6.9803	7.4771	
8.3207	7.8545	8.4117	
446.10	413.23	450.612	
9.5855	9.0953	9.7099	In the fourth trial, the decided inferiority of effect to the preceding is probably to be ascribed to the coating of soot upon the flues and the want of sufficient draught to burn completely the products of combustion.
1.4219	1.4122	1.421	
6.231	6.0876	6.2182	
Open.	Closed.		
U. 4.	U. 4.		

(*Copy.*)

No. 3.

Bituminous coal from Pictou, Nova Scotia, sent by Mr. Cunard, agent of the General Mining Association of London.

Trial of sample from agents.

The coal of this sample is, in every external character, entirely similar to that from the same mining district obtained from New York. The specific gravity of one specimen (*a*) was 1.3155; that of another, (*b*,) 1.3352. The mean of these makes the weight of the cubic foot in the solid state 82.835 pounds. The actual weight, determined by 20 trials in the charge-box, is for the least 45.5, for the greatest 52·125, and for the average 49.25 pounds per cubic foot, or 0.5945 of the calculated weight. Hence the space to receive one ton is 45.482 cubic feet.

The moisture expelled by thoroughly drying specimen *b* was 1.079.

The coking of *a* caused a loss, including moisture, of 26.413 per cent. The process having been conducted very slowly, the powder did not become agglutinated; but another portion of the same powder suddenly exposed to a bright red heat, became converted into a well-formed mass. Of specimen *b*, a portion coked so slowly, and at so low a heat, that the gas did not take fire, exhibited a loss of 27.1 per cent. Another portion of the same powder, coked rapidly, so as to become completely coalescent, lost 29.34 per cent.

The earthy matter in *a* was 10.09, in *b* 11.404 per cent. Hence the proximate constituents of these two specimens are—

Analysis.

	Specimen *a*.		Specimen *b*.	
Moisture.....(not separately determined)			1.079	
Volatile matter.....	26.413	other than moisture	26.021	by slow coking.
Earthy matter.....	10.090		11.404	
Fixed carbon.....	63.497		61.496	
	100.		100.	
Volatile to fixed combustible	1 : 2.404		1 : 2.3633	

The moisture expelled from 28 lbs., dried in the steaming-apparatus, amounted to 0.7812 per cent. The volatile matter, including moisture, from the mean of the two specimens above given, is 26.756.

During the two experiments on evaporation, there were burned 1962.5 pounds of this coal, and the—

Weight of ashes withdrawn was.....	116.00 lbs.
of clinker.....	121.75 "
of soot.....	8.75 "

The ashes lost 0.04077 of their weight, and the soot 0.60144, by re-incineration. Reducing the weights of these two, and deducting 1.029 lbs., for the ashes of 355.25 lbs. of pine wood, we have left 245. 481 lbs., for the total waste from the above weight of coal, or 12.508 per cent.

From these data it would seem that the coal is composed of—

Practical analysis.

Moisture, (from 28 lbs.) - - -	0.7812
Other volatile matter, (from two specimens) -	25.9753
Earthy matter (from 1962.5 lbs.) - -	12.5085
Fixed carbon, (calculated by difference) -	60.7350
	100.

Volatile to fixed combustible 1 : 2.5929.
The ashes weighed 39.01 lbs. per cubic foot.
The clinker " 38.00 " "
The soot " 3.82 " "

Clinker.

When re-incinerated or calcined, the clinker became of a dark drab or light brown colour, the ashes of a light reddish-gray, and the residue of the soot a light drab colour. The ashes from analysis of *a* were pure white ; from *b*, dirty white.

The clinker, as it came from the furnace, was black, vitreous, and porous, in masses tolerably friable, and not apparently prone to adhere to the grate. Much shaly matter attaches itself to the vitrified portions.

With the oxide of lead, specimen *b* gave 23.355 times its weight in metallic lead. Deducting moisture and earthy matter, we have left 0.87517 of combustible ; by which, dividing the above, we get $\frac{23.355}{.87517} = 26.686$.

For the reason assigned in regard to the preceding sample which accompanied this, the trial in smith's forges and in open grates was necessarily dispensed with. This is the less to be regretted in the present instance, as the sample of Pictou coal already described has been tested in the forge ; and as the action of the two samples is in other respects almost identical, there is no reason to doubt that in this particular also they would be found to coincide.

The mean time required to bring the boiler to a steady rate of evaporation was 0.85 hour, or 51 minutes. The weight of coke left unburnt on the grate was very small, being on the first trial, 5 pounds, and on the second 2.5. The combustion commenced promptly, and the flame was long, and accompanied by considerable smoke. The large amount of clinker (more than 50 per cent. of the total waste) rendered it necessary to remove the heavier masses within a few hours after the fire was kindled.

DEDUCTIONS FROM TABLES CLXIII, CLXIV

Experiments on

		Nature of the data furnished by the respective tables.	1st Trial. (*Table CLXIII*)	2d Trial. (*Table CLXIV.*)
			September 27.	*September* 28.
Results of Trial. N 3. Class IV.	1	Total duration of the experiment, in hours	25.083	24 383
	2	Duration of steady action, in hours	5.267	5.333
	3	Area of grate, in square feet	14.07	14.07
	4	Area of heated surface of boiler, in square feet	377.5	377.5
	5	Area of boiler exposed to direct radiation, in square feet	18.75	18.75
	6	Number of charges of coal supplied to grate	10.0	10.0
	7	Total weight of coal supplied to grate, in pounds	992.25	977.75
	8	Pounds of coal actually consumed	987.25	975.25
	9	Pounds of coal withdrawn and separated after trial	5.0	2.5
	10	Mean weight, in pounds, of one cubic foot of coal	49.6125	48.8875
	11	Pounds of coal supplied per hour, during steady action	149.212	127.648
	12	Pounds of coal per square foot of grate surface, per hour	10.6	9.072
	13	Total waste, ashes and clinker, from 100 pounds of coal	11.62	12.505
	14	Pounds of clinker alone, from 100 pounds of coal	5.7655	6.6199
	15	Ratio of clinker to the total waste, per cent	49.347	52.935
	16	Total pounds of water supplied to the boiler	7545.0	7204.0
	17	Mean temperature of water, in degrees Fahrenheit	70°.5	67°.3
	18	Pounds of water supplied at the end of experiment, to restore level	270.0	406.0
	19	Deduction for temperature of water supplied at end of experiment, in pounds	37.0	57.0
	20	Pounds of water evaporated p. hour, during steady action	1122.86	936.68
	21	Cubic feet of water per hour, during steady action	17.96	14.987
	22	Pounds of water per square foot of heated surface per hour, by one calculation	2.974	2.481
	23	Pounds of water per square feet, by a mean of several observations	2.988	2.498
	24	Water evaporated by 1 of coal, from initial temp. (a) final result	7.6049	7.328
	25	Water evaporated by 1 of coal, from initial temp. (b) during steady action	7.522	7.338
	26	Pounds of fuel evaporating one cubic foot of water	8.2174	8.529
	27	Mean temperature of air entering below ash-pit, during steady pressure	64°.15	64°.33
	28	Mean temp. of wet-bulb thermometer, during steady pressure	55°.08	55°.8
	29	Mean temperature of air, on arriving at the grate	209°.15	233°.13
	30	Mean temp. of gases, when arriving at the chimney	295°.0	330°.0
	31	Mean temperature of steam in the boiler	231°.0	232°.0
	32	Mean temperature of attached thermometer	62°.115	59°.67
	33	Mean height of barometer, in inches	30.146	30.249
	34	Mean number of volumes of air in manometer	5.0246	5.004
	35	Mean height of mercury in manometer, in atmospheres.	.5546	.5572
	36	Mean height of water in syphon draught-gauge, in inches	.3241	.3525
	37	Mean temperature of dew-point, by calculation	46°.78	48°.63
	38	Mean gain of temp. by the air, before reaching grate	145°.0	168°.8
	39	Mean difference between steam and escaping gases	67°.66	107°.06
	40	Water to 1 of coal, corrected for temp. of water in cistern	7.5864	7.3148
	41	Water to 1 of coal, from 212°, corrected for temperature of water in cistern	8.6249	8.3446
	42	Pounds of water, from 212°, to one cubic foot of coal	427.9	407.94
	43	Water, from 212°, to one pound of combustible matter of the fuel	9.7589	9.5373
	44	Mean pressure, in atmospheres, above a vacuum	1.4389	1.4408
	45	Mean pressure, in pounds p. sq. inch., above atmosphere	6.4819	6.5104
	46	Condition of the air-plates at the furnace-bridge	Closed.	Open.
	47	Inches opening of damper, (U. upper)	U. 8.	U. 8.

OF JOHNSON'S REPORT, PAGES 478-481.

Pictou (N. S.) coal, (Cunard, agent.)

Averages.	Remarks.
3.75	In a very close approach to total combustion, as well as in many other of its properties and modes of action, this sample manifests its affinity with the Pictou coal procured in New York.
49.25	
138.43	
9.836	
12.0625	
6.1927	
51.141	
1029.77	The rate of evaporation with air-plate open is 16.5 per cent. less rapid than with the plate closed.
16.4735	
2.7275	
7.4664	
7.43	
8.3732	
221°.14	
312°.5	With the air-plate open, as in the second trial, the gases going to the chimney had a temperature 35° higher than with the same plate closed, as in the first experiment. The considerable coating of soot on the flues may have helped to keep the gases at their high temperature, and to diminish the evaporative effect, as seen in lines 41 and 43.
.3383	The second trial had the advantage of a stronger draught than the first.
156°.9	
87°.33	
7.4506	
8.4848	
417.92	
9.6481	
1.4398	
6.4962	

DRUMMOND COAL ON QUEBEC STEAMERS.

Drummond coal on Quebec steamers.

No opportunity for making a steamer-trial of the Drummond coal offered during last season, but a few facts concerning the success with which it is used on the Quebec and Gulf Ports Steamship Company's steamers, "*Secret*," "*City of Quebec*," and "*Gaspé*," may not be out of place here. These steamers run from Quebec to Pictou, touching at Gaspé, Baie des Chaleurs, and several other points on the Gulf of St. Lawrence. The following information was obtained through Mr. A. P. Ross, of Pictou, agent Q. and G. P. SS. Co., (to whom my thanks are due for his interest in this matter,) by sending blank forms to the engineers of the different steamers, including questions and suggestions, which forms, being filled up with the requested information, were returned to me. Without including the questions, or adhering to the words of the original blanks, a general abstract will be given of their contents.

STEAMSHIP "SECRET."

Form filled up and signed by Thomas D. Finegan, engineer.

SS. "Secret."

Steamship "Secret" is 622 tons register. Her engines are oscillating, two cylinders 50 inches diameter, 54-inch stroke. Two boilers; close bottom; return tubes. Working pressure of steam from 17 to 20 lbs.

This steamer has used Drummond coal about five months (Nov., 1869.) The quantity taken on board per trip is from 105 to 137 tons, and about 27 tons are used per day. In comparison with other coals, Mr. Finegan states:—"I have found in practice, 20 tons of best Welsh coal, in evaporative power, are equal to 27 tons Intercolonial (Drummond) coal, and 27 tons Intercolonial coal equal to 30 tons Scotch. All things considered, I would rather have Intercolonial coal." His further statements indicate:—That if the opening between the grate-bars of the steamer-furnace are only from $\frac{3}{4}$ to 1 inch apart, no slack is wasted by falling through the grate unconsumed; that the coal cakes but little on the grate; that but little clinker is formed, but that what there is, is in sheets of some thickness; and that compared with the English and Scotch coals as used on the steamer, this coal gives "considerably more" ash. In answer to the final question: "Is there anything else you can think of, either for or against the coal?" Mr. Finegan states: "Intercolonial coal has given me good satisfaction, all things considered. I look upon it as good quality steam-coal. Leaving so large an amount of ash occasions much extra work, but this is more than compensated by the saving in grate-bars, which are no small item of expense, and they last much longer with this coal, than when Welsh (or many other) coals are used."

STEAMSHIP "CITY OF QUEBEC."

Information received from Thomas Palaquie, engineer.

SS. "City o Quebec."

Steamship "City of Quebec" is 499 tons register. Engines oscillating, with two cylinders 57 inches diameter × 56 inches stroke. Two boilers with eight fires. Working pressure of steam, 18 lbs.

The Drummond coal has been used on this steamer since 17th May, 1869, (Nov., 1869.) The quantity taken on per trip is about 130 tons, and with eight fires and running at full speed, about 36 tons are used per day.

The coal generally burns well, not falling to pieces when thrown on a hot fire, and not caking. It forms clinker in sheets, but this clinker does not stick to the bars, and the ash, which is white, is about twice the quantity produced by English or Scotch coal.

STEAMSHIP "GASPE."

Form filled up and signed by John Campbell, engineer.

S.S. "Gaspe,

The steamship "Gaspé" is of 231 tons register. She has oscillating engines (two cylinders 32 inches diameter × 3 feet stroke), and one tubular boiler. When this information was furnished (Nov., 1869), the Drummond coal had been used but two trips on this steamer. The quantity of coal taken in per trip stands as follows:—At Quebec, 70 tons Scotch; at Pictou, from 63 to 65 tons Intercolonial (Drummond); the amount of the last burnt per day, equalling about 12 tons.

In comparison with other coals, Mr. Campbell states:—

"I find that Intercolonial coal lasts longer than Scotch; in proof of this: 4th trip from Quebec, 65 tons Scotch, 109 hours running time; 4th trip up, 58 tons "Intercolonial," 118 hours running time; 5th trip down, 62 tons Scotch, 98 hours. You will see that we ran 118 hours with 58 tons Intercolonial, against 65 tons Scotch coal in 109 hours."

Further statements indicate that no inconvenience is felt from the slack falling through the grate, when the bars are properly pitched; that the coal cakes on the grate when damp; that it forms whitish-brown clinker in sheets which does not adhere to the bars; and that it leaves a considerable quantity of yellowish-gray ash, which is "sometimes nearly black."

PICTOU COALS ON OCEAN STEAMERS.

Trials on the Allan Line of Steamships.

For some months past, coals from the Acadia-West and Drummond collieries have been used on the large ocean-steamers of the Montreal Ocean Steamship Company (Allan's line), on the homeward voyages from Montreal in summer and Portland in winter, to Liverpool and Glasgow.

The regular supply of coal has, I believe, been furnished by the Acadia colliery (Acadia steam-coal), though several thousand tons of Intercolonial (Drummond) coal have also been used. Through the kindness of Messrs. H. & A. Allan, I have been allowed to examine the reports of the engineers of a number of their steamers, concerning comparative trials of these coals (as supplied at Montreal and Portland), with the Welsh steam-coals supplied for the outward voyages, at Liverpool, and have permission to include the more important results of these trials in this Report. The general result appears to be satisfactory, except in one particular, viz.:—the large amount of ash produced; but the inconvenience felt from this cause is in most cases counterbalanced by the small amount of sulphur in the coals, the absence of adherent clinker, and the consequent preservation of grate-bars.

Daily consumption.

Consumption, as compared with Welsh.—The record of comparative daily consumption of these and Welsh coals during some of the trials, is as follows:—

1. S.S. "Peruvian," (Report Jan., 1869.)
   63 tons 10 cwt. Acadia = 50 tons 10 cwt. Welsh = 57 tons 10 cwt. mixture of the two coals = 124:100:115.
2. S.S. "Nestorian," (Report 1st Feb., 1869.)
   68 tons Intercolonial = 55 tons Welsh = 123:100.
3. S.S. "Hibernian," (Report 9th Feb., 1869.)
   62 tons Pictou (principally Intercolonial,) = 50 tons Welsh = 124:100.
4. S.S. "Nestorian," (Report 17th Feb., 1869.)
   69 tons Intercolonial = 59 tons Welsh, (pressure of steam being as 18:25.) This (taking steam-pressure into consideration,) = 162:100.
5. S.S. "Hibernian," (Report 1st March, 1869.)
   58½ tons mixed Acadia and Intercolonial = (estimated) 51 tons Welsh as received in Portland, or 48 tons as received in Liverpool = 121:106:100.
6. S.S. "North American," (Report has no date.) It states that 45 tons of Acadia coals are consumed per day, being same consumption as with Welsh, but pressure of steam is 4 or 5 lbs. less than with Welsh. If pressure of steam with Welsh = 25 lbs. (?), then ratio of Acadia and Welsh would = 118:100.
7. S.S. "Nestorian," (Report of 28th March, 1870.)
   66 tons Acadia = 59 tons Welsh coal, steam-pressure being 22½:25 lbs. This indicates the ratio of 122:1-00, taking steam-pressures into consideration.

AVERAGE RATIOS OF DAILY CONSUMPTIONS, FROM ABOVE TRIALS.

1.	Welsh* to Acadia	100.0 : 121.3	Comparison Pictou and Welsh coals.
2.	" " Intercolonial, including trial No. 4.†	100.0 : 136.3	
3.	" " Intercolonial, rejecting trial No. 4	100.0 : 123.5	
4.	" " mixture, Welsh and Acadia	100.0 : 115.0	
5.	" Acadia and Intercolonial	100.0 : 121.0	
6.	" " Welsh as delivered in Portland	100.0 : 106.0	

Ashes and Clinker.—Mr. Flett, chief engineer of the S.S. *Peruvian*, in his Report of June, 1869, says :—"There is a large quantity of ashes from the Acadia coals, but little clinker, which enables us to clean the fires easily, as nothing sticks to the bars." Mr. Dick, chief engineer of the S.S. *Hibernian*, says :—"The fires are easily cleaned, that is, the clinkers do not stick to the bars, neither do they burn the bars." The other engineers complain of more or less clinker from both Acadia and Intercolonial coal ; the Acadia, however, appears to give the least trouble in this respect. This is owing to the fact that the Intercolonial coal is the softest, and if not properly stoked would be inclined to clinker. The fact that some engineers burn these coals without clinker, is sufficient proof that it is possible to do so in every case. As I shall presently show, it is probable that, if these coals are burnt with a fire, at the bridge, deep at the fire-door, with proper perforations in the door, (equalling at least 8 or 10 square inches per square foot of door,) there should be no difficulty in keeping good steam, and avoiding the large flat clinkers which are complained of; but attempts to burn these caking coals on a thin flat fire such as is generally made in burning Welsh steam-coals, which are not inclined to cake, will never result in success. Ash and clinker.

The amount of refuse from these coals in proportion to Welsh, is variously estimated by the different engineers ; the average seems to be, in buckets thrown overboard perwatch of four hours :—Welsh, from 15 to 18 ; Pictou, from 35 to 45.

Smoke, etc.—The only mentions made of smoke in these reports occur in the reports of Messrs. Jack, of the *Hibernian*, and McMaster, of the *Nestorian*, both of whom complain that when urging the fires to get all the steam possible, large volumes of smoke and flame are seen coming from the funnel. I need hardly say that this manifestly results from an improper arrangement of the draught, and it would appear from this that no air is supplied above the fire, to assist in burning the volatile matters passing off from the coal in coking, previous to combustion. This must result in a great loss of coal, and can be partially remedied by the same change in Smoke.

* Welsh, "best Welsh steam-coal, delivered in Liverpool."

† The low result of trial No. 4 is probably due to bad management of the coal. It is so discordant with other results that I think it should be rejected.

management mentioned above, viz.:—proper stoking, and perforated doors. This subject will be further considered under the next heading, paragraph "*Smoke consumption.*"

GENERAL REMARKS ON STEAM-TRIALS.

General remarks on steam trials.

The general result of all the trials above described has been to demonstrate the fitness of the coals used, for steam production, whether under stationary marine or locomotive boilers. As the result of each separate trial can be compared with similar trials of foreign coals, by reference to any work on standard coals or engineering practice, it seems unnecessary to make any such comparison here.

A few remarks on late experiments on the consumption of such coals, however, may not be out of place, but though of very great importance to our coal trade, a full discussion of the subject will not be practicable, without extending this Report far beyond the limits to which it must be necessarily confined. A prejudice existed for a long period against using bituminous coals as steam-producers, especially in the Navy, on account of the large amount of smoke produced in burning them, and their low evaporative power, as compared with anthracites, or the so-called free-burning coals of the Welsh coal-fields. The heavy black smoke emitted from the funnel of a steamer burning these coals rendered them quite unfit for the use of ships of war, and in towns and cities became a serious nuisance. Their evaporative powers, as has already been stated, were supposed to be dependent on their content of fixed carbon, which supposition seemed to be quite justified by practical experiments. The most careful trials with the old style of furnaces failed to give them the value of the Welsh steam-coals, in proof of which I may cite the final results of the British experiments (De la Beche and Playfair's), in evaporative powers:—

Former prejudices against bituminous coals, as steam producers.

Average of	37	samples	from	Wales	9.05	lbs.
"	17	"	"	Newcastle	8.37	"
"	28	"	"	Lancashire	7.94	"
"	8	"	"	Scotland	7.70	"
"	8	"	"	Derbyshire	7.58	"

Resemblance of Pictou and North Country coals.

Of the above list of coals, the coals of the Pictou district approach nearer to the Newcastle Hartley, or North Country coals than to any other class well known, and it will be, therefore, of the greatest interest to show the change of opinion which has taken place with regard to these coals within the last few years; to mark how all the old prejudices have disappeared, and to ascertain with what success these coals are now consumed as steam-producers.

To accomplish this object in the most direct manner, I cannot do better

than quote from the "Report of a Committee appointed by the North of England Institute of Mining Engineers, to investigate the smoke question" (dated Oct. 24th., 1860.) After mentioning the causes that led to the appointment of this committee, they state:— Smoke consumption.

"They (the Committee) cannot, however, forbear remarking that there is really very little left for them to do. A few years ago, in 1855, there was an impression that North Country steam-coal not only made smoke when burnt, but was of an inferior evaporative power to that of the so-called smokeless Welsh coal. Since then, on two subsequent occasions, this has been proved, most satisfactorily, to be an error. In 1856-7, experiments were made at Elswick, conducted by Sir William Armstrong, Mr. J. A. Longridge and Dr. Richardson, which fully demonstrated that Hartley could give, without smoke, 12.9 lbs., and Welsh 12.35 lbs. of water evaporated from 212°, per pound of coal, in an ordinary marine boiler; and in 1864, Mr. Miller, at the request of the House of Commons, made a series of experiments which proved again most satisfactorily that Hartley could give without smoke 10.68 lbs., and Welsh 10.13 lbs. of water evaporated from 100 per pound of coal. Again, at Wigan, in 1867, Messrs. Fletcher and Dr. Richardson conducted a series of experiments proving most conclusively that a bituminous coal, more difficult even to manipulate in the fire than the coal of this district, can be economically and *smokelessly* consumed. All these results have been accomplished with the smallest possible alteration of the furnace and bars of ordinary marine boilers. Your Committee, therefore, have, from many and various sources, the highest authority for stating that, as far as experiments can do so, the question is practically *solved*, and more particularly in connection with any ordinary quality of round coal, and in Cornish or marine boilers of ordinary construction. It could hardly be expected that any further experiments would produce better or more conclusive results, or be attested by gentlemen of higher reputation and position. Lake experiments.

* * * * * * * * * * *

"Believing, as they do, that the semi-bituminous steam-coal of this district can be burnt without smoke, so as to give as high, if not a higher and more speedy evaporative power, than Welsh (as might be expected from its chemical composition), your Committee can by no means aver that this most important fact is comprehended by the great bulk of consumers; but they are not of opinion that any further experiments in this direction are necessary, as it seems to them that data on this subject are so numerous already, that the public may be properly left to draw their own inferences thereon.

"If your Committee were asked for the reason for so much incredulity on a subject so important to the interests of the Northern coal-owners, they

would suggest that it, to a certain extent, arises from the fact that the steamships built in the neighbouring ports are not, as a rule, by any means successful either in their attempts to prevent smoke, or to obtain the highest results from the coal of the district. These steamers, going from port to port, and from country to country, assist in advocating the views of those who refuse to recognise the value of the Northern steam coals, and your Committee regret that the boilers of these ships at least are not constructed so as to bear out the results so laboriously obtained at such great cost."*

Many of the statements in the above extract will apply with almost equal force to our own coals. It is scarcely possible that we shall obtain the very high results in evaporative power above indicated, from the Pictou coals, from the fact that the amount of ash in these coals almost invariably exceeds that in the coals of the North of England; but it is certain that with proper furnaces, the evaporative power of our coals may be materially increased, probably to the extent of from twenty-five to thirty per cent., and there seems no reason to doubt, that, in the matter of smoke, our coals may be as successfully burnt as those of the North Country.

Mr. Bunning's experiments.

In this connection it will be interesting to examine into the success with which the Newcastle coals are burnt without smoke, and to this end, an abstract of the experiments of Mr. T. W. Bunning, of Newcastle-on-Tyne, on the steamer "*Weardale*," will most conclusively show the wonderful improvements made from the results of the old system of burning the coals, by a very slight change in the furnaces and bars. A series of smoke-trials were made on this steamer with the ordinary furnace, fitted with grate-bars five feet long, and the exact amount of smoke produced by Hartley coal was obtained by a method presently to be described. An alteration was then made in the furnaces, which consisted simply in shortening the bars to three feet six inches, and introducing an *air-plate* (of fire-bricks with open spaces between them, hung on iron bars), at the back of the fire. Underneath this air-plate was a flue, or open space, separated from the ash-pit of the furnace by a cast-iron plate, carrying the brick forming the bridge proper of the furnace. This cast-iron plate was pierced with a hole giving communication between the ash-pit and air-plate flue, when open, and thus admitting air between the fire and the chimney, through the spaces between the fire-brick forming the air-plate; or this hole could be closed by a shovel-full of ashes and cinder. Beside these simple alterations the furnace-doors were fitted with perforated flash-plates, through which the air was allowed to pass into the furnace, in front of the fire, but above the grate. After the alteration, another series of experiments was tried with the steamer, and with the most signal success. The results were published in the Transactions of the North of England Institute of Mining Engineers, and accom-

* Transactions North of England Institute of Mining Engineers, vol. xviii, pp. 37–38.

pany a short paper by Mr. Bunning, a portion of which will subsequently be quoted. As it will be impossible to reprint in full, the tabulated results of these trials, it will be necessary to explain the method adopted (and now, I believe, agreed to as the standard by the Imperial Government), for estimating the exact amount of smoke produced by a given coal, consumed in the furnaces of any particular steamer. It is this:—Let the smoke issuing from the funnel of a steamer be noted every minute for an hour, upon a blank table, subdivided into minute-columns, similar to the table published with the Acadia coal-trial on the steamer "St. Lawrence" (Trial No. 2, of this Report). Let the figure 1, placed in a te-space, indicate that the very faintest possible smoke, a mere ation of light-coloured gas was visible; 2, that this was increased, and so on to 6, indicating the densest black smoke. Having obtained these *smoke-marks* for an hour, the addition of them gives the *smoke-equivalent* for that time. This understood, the extract from Mr. Bunning's paper above referred to, will become intelligible to the reader. After referring to the tabulated record showing the smoke-marks for every minute during his experiments, he states:—

Rule for estimating smoke.

"It will be seen that before the alteration, this smoke-equivalent averaged 107.9 over 25 experiments; that frequently, and for several consecutive minutes, dense black smoke was issuing from the chimney, and that there was rarely any actual cessation from smoke; while after the alteration no smoke of greater intensity than 2, was ever visible, and this only nine times in eighteen hours, for a minute each time; and that during the same eighteen hours the average smoke-equivalent was 7.7, each mark so rarely exceeded 1. This indicates that the very faintest possible smoke was visible only for 7.7 minutes in each hour, no smoke whatever being visible for the other 52.3 minutes. It would be vain to look for, nor indeed can any better results be found, even when the best of the so-called smokeless coals are burnt; for all practical purposes, therefore, good Hartley coal, as consumed in the *Weardale*, may be considered as smokeless as any other known coal. The plate* shows the alteration made to the fire-bars and bridge; the former were reduced from 5 feet to 3 feet 6 inches. The doors were not changed, and those shewn are those used by the Admiralty, admitting air at the bottom.†

Experiments on the Str. "Weardale."

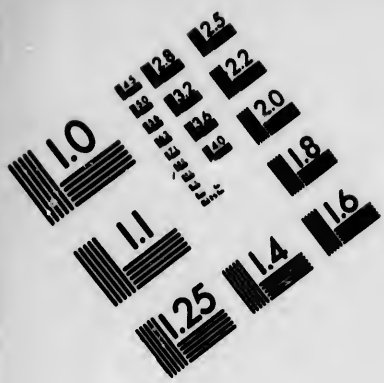
"The secret of burning the North Country steam-coal, and in fact all other good steam-coal, is to put it on as large as possible, as thick as possible, and to have as great a draft as possible, so as to burn off as large an amount per square foot of grate-surface as possible."‡

Rule for burning North Country steam-coal.

* Published with Mr. Bunning's paper.

† That is, the bottom of the door; the air passing into the fire through a perforated flash-plate.

‡ "*On Experiments on the Weardale.*" Trans. N.E. Inst. Mining Engineers, vol. xviii., pp. 105 et seq.



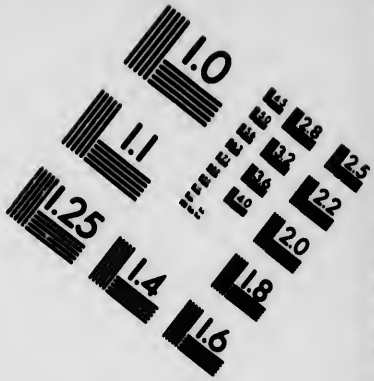
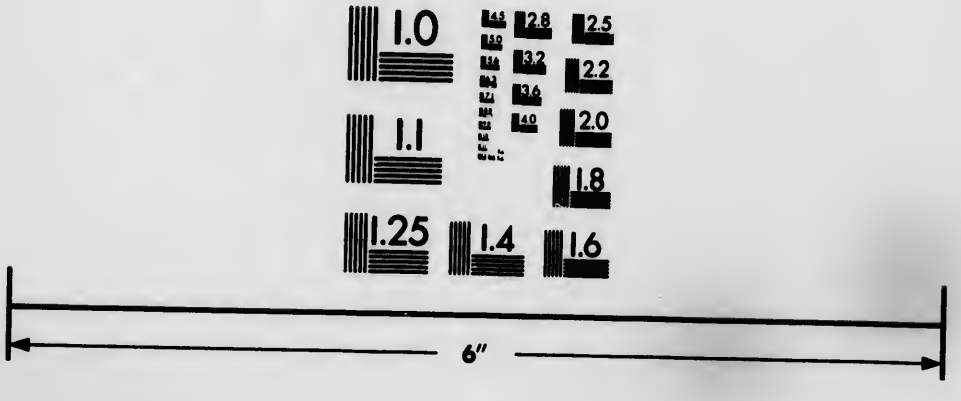


IMAGE EVALUATION TEST TARGET (MT-3)



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Farther trials and alterations.

Since these trials, which were carried out in the winter of 1868-9, farther experiments have been made by Mr. Bunning on the Weardale, and some slight alterations made, among which may be mentioned the placing of a door at the hole piercing the plate between the ash-pan and air-plate flue, which being moved by a bar extending to the front of the furnace, permits the admission of air, *at will*, behind the fire. Under date of 14th April, 1870, Mr. Bunning (to whom I am indebted for much information on this subject, which I would here gratefully acknowledge, writes me :—

Success.

"We consider the Weardale, now perfect; she makes absolutely no smoke, and keeps her steam well."

A proper discussion of the rationale of these experiments, and of their importance to our coal-trade, must be postponed to some future occasion. Much more might be said in favour of the use of steam-coals of the class under consideration, and it can be clearly proved, that, if properly burnt, they are at least as economical, as smokeless, and as easily stoked as any other class of coals.

Use of Newcastle coal in the Navy.

The experiments above quoted, in connection with Government trials made at Devonport, already mentioned, have produced a material change of opinion with regard to Newcastle coal, and it has now taken a position second to none, among coals for the Navy, where it is chiefly used in admixture with Welsh coal, and the testimony of the very highest authority, is that a very large saving has already been effected by its use.

Necessity for steam and smoke-trials of our coals.

It is hoped that enough has already been said to call the attention of our coal-owners and consumers to the urgent necessity of practical trials of a similar character to those above mentioned. Such experiments could be carried out at a very trifling cost, on any steamers, without interfering with their regular voyages; and though the great results of the North Country experiments might not be obtained, still, a great addition would be made to our knowledge of the coals, and that a very material improvement in the matter of steam and smoke would be made, cannot be doubted.

I shall close these remarks, which have already exceeded the length originally assigned to them, by an extract from a circular of the Coal Trade Association of Newcastle-on-Tyne, just received from Mr. Bunning. It is of interest as showing the results of the very latest trials.

RESULT OF EXPERIMENTS AT PORTSMOUTH, 1869-70.

Experiments at Portsmouth 1869-70.

"A very comprehensive series of experimental trials have been carried out during the past twelve months on board Her Majesty's steamers "Urgent" and "Lucifer," at Portsmouth, with Welsh and North-

Country coal mixed, and burnt in two forms of furnace, for the purpose of ascertaining the best proportions in mixed coal, and form of furnace for the consumption of smoke. The trials have been carried out under the direction of Captain E. Rice, A.D.C. to the Queen, commanding the Steam Reserve at Portsmouth, and the superintendence of Mr. G. Murdock, Chief Inspector of Machinery to the Reserve; and the results are considered to be so important, that orders have been issued from the Admiralty for the furnaces in the boiler-rooms of her Majesty's ships to be altered according to the plan finally adopted in the trials as the best for the consumption of smoke. When the comparative trials between the ordinary and the new form of furnace commenced, the proportions of the mixed coal burnt were one-third North-Country and two-thirds Welsh; but in all the later trials the coals have been burnt in equal proportions, and under these latter conditions less smoke has been emitted from the smoke-consuming furnace funnel than has been emitted from the funnel over the ordinary form of furnace, when the latter was burning the very best description of Welsh coal. The last three trials made on board the "Urgent" afford conclusive evidence of the success of the new form of furnace over the old. In the trial made on the 27th ult., both sets of furnaces were used, the coal burnt being Ferndale and Cowpen's Hartley, in equal proportions. The report of this trial gave the following results:—

Change of furnaces in the navy.

H. M. S. "Urgent."

	New Furnace.	Old Furnace.
Smoke	1.55	4.55
Coal burnt per hour	2,940 lbs.	3,294 lbs.
Producing		
Ash	23.14	32.75
Soot	2.82	5.16
Clinker	35.08	25.00

"The last two trials made were on the 2nd and 11th insts., the new furnaces only being used on the former, and the old furnaces only on the latter trial, the coal burnt in each instance being equal quantities of Powell's Duffryn and Cowpen Hartley, with the following results:—

	New Furnace.	Old Furnace.
Coal burnt per hour	2,912	3,397.3
Producing		
Ash	17.73	24.34
Soot	1.84	4.06
Clinker	31.0	40.6

"In these two trials, the new furnaces exhibited a saving upon the old, of 14.28 per cent. in fuel, an increase of 7.56 per cent. in horse-power, and a positive gain in the consumption of smoke, of 21.84 per cent."

PRACTICAL TRIALS IN GAS MAKING.

Requisites of a gas-coal.

The most important requisites of a gas coal are :—1st. That it contains a large amount of volatile combustible matter (gas);—2d. That this volatile matter be of good illuminating power, and as free as possible from sulphur, and—3d. That the coke furnished by the carbonization of the coal be bulky, and at the same time firm, (*i. e.* not inclined to be granular.)

The importance of the first requisite, will be evident to all. The percentage of volatile matter in true coals usually employed in gas-making, is from 25 to 40 per cent., and in cannels it rises to 60 or 70 per cent.

The true bituminous coals of this district which are now being worked, average, according to the latest analyses, as given in the first Section of this Report, about 28 or 29 per cent. of volatile matter ; the content of the hardest being 20.46 per cent., and of the softest being 38.84 per cent.

Gas-content.

The oil coals, oil shales, and a single cannel range higher in gas-content, the stellarite reaching 68.38 per cent., and Lawson's cannel 41.18 per cent., which last figure is not, however, a high percentage of volatile matter for a cannel. That the percentage of volatile matter, given by analysis in the small way, is not always a true index of the value of a gas-coal, will be seen by a reference to the analyses of the Foord-pit coal, which stands nearly at the head of the list of Pictou (true) coals, as a gas-producer. The percentage of volatile matter appears rather low in this case, in fact so much below what would be expected from so good a gas-coal, that I am inclined to suspect that the samples analysed in the small way, were not fair averages of the produce of the colliery.

Quality of gas.

That the gas produced from the coal be of good illuminating power, is most important, will also be seen, though from the fact that the standard of illuminating power can easily be raised by the addition of a few per cent. of some rich cannel, or substance of the character of the stellarite, many coals, which produce gas of a low standard, but in large quantity, (if they coke well,) are often used as gas-coals. The stellarite has been used to raise the standard of illuminating power of gas from other coals ; as are also, torbanite, albertite, cannels, and many oil shales. To instance a case of this kind, I may state that Mr. Thompson, of the Pictou Gas-works informs me that when using a coal giving *per se* 15-candle gas, he adds 10 per cent. of Leshmahagow cannel, in order to raise the gas to the standard of 18 candles.*

* The standard candle in testing gases, is of spermaceti, burning at the rate of 120 grains to the hour. To compare the illuminating powers of gases, the light given by a standard burner burning five (5) cubic feet per hour of the gas under examination, is compared with the light of one of these standard candles, the result giving the *candle-*

The majority of the coals of the Pictou region furnish an excellent coke in the gas-retorts, if properly carbonised, as will be abundantly proven by the statements to be given below from some of the first gas-chemists of this continent. Statements have recently been published to the effect that coke from these coals is worthless. In a single case this may be warranted; in the majority of cases it is not, as from a number of the coals I have seen most excellent coke made in the gas-retorts of the Pictou works. It is true that if the heat is not properly applied, the coke cannot be properly formed, and a few of these coals will never be successfully coked, but the testimony of our first gas-chemists, such as Buist of Halifax, and the engineer of the Boston Gas works, who have used many thousand tons of the coals, is that some of them furnish good merchantable coke. Coke.

The greater number of the coals of this district will, I believe, compare favourably with those of any district of the world in regard to sulphur. A number of analyses in the first section show the sulphur-content of the different coals, which in most cases is considerably below 1.00 per cent. These determinations of sulphur may be compared with the following table, giving averages of determinations of sulphur in a large number of the coals of Great Britain, from the analyses given in the reports of the British Admiralty Trials: — Sulphur.

					Per cent.
Average of	37	samples from	Wales.	gave of sulphur	....1.42
"	17	"	Newcastle,	"	.... .94
"	28	"	Lancashire,	"	....1.42
"	8	"	Scotland,	"	....1.45
"	8	"	Derbyshire.	"	....1.01

Further statements concerning the small amount of sulphur in Pictou coals, will be found in the extracts of letters from Messrs. Buist and Greenough, given below.

GAS TRIALS AT THE PICTOU GAS-WORKS.

Mr. Alex. Thompson, of the Pictou Gas-works, has used all the coals which have been worked to any considerable extent in this region, and he has been kind enough to supply me with notes of his experience, from which the following tabulation has been compiled. Gas trials at Pictou.

power of the gas. Thus if we suppose a gas burnt in a five-foot burner to give fifteen (15) times the amount of light furnished by one standard candle, the gas is said to have 15-candle power or to be 15-candle gas. The standard of gas in our large cities ranges from 13 to 18-candle power.

PRODUCTION OF GAS, AND QUALITY OF GAS AND COKE, FROM VARIOUS COALS AT THE PICTOU GAS-WORKS.

(FROM NOTES OF MR. ALEX. THOMPSON, MANAGER.)

Company shipped by, and name of mine.	Cubic feet of gas (per ton of 2240 lbs.)	Illuminating power (candles.)	Bushels of coke per ton.	Character of coke.	Remarks.
General Mining Association.					
Foord Pits, (1869 shipments.)	8,000	18	35	Good.	
Albion (Old) Mines.....	7,700	16	34	"	
Forster Pit.....	6,000	13	32	Not good.	Coke unsaleable.
Dalhousie Pit.....	7,500	15	32	Good.	
Cage Pit, (old shipments)....	7,800	17	34	Good.	
Acadia Coal Company.					
McGregor workings.....	7,600	14	34	Fair.	Coke firm, but sulphurous.
Fraser Mine, stellar coal....	11,000	36	.....	.....	Coke worthless.
" oil-shale.....	8,000	30	.....	.....	" "
Acadia Colliery, west slope.	7,000	13	32	Not good.	Coke granular.
Intercolonial Coal Company.					
Drummond Colliery.....	7,700	15	34	Good.	
Nova Scotia Coal Company.					
Nova Scotia slope.....	7,000	14	32	Fair.	Coke saleable.
Montreal and Pictou Coal Co.					
Montreal and Pictou pit....	6,000	13½	28	Not good.	
Pictou Coal Mining Company.					
Marsh Colliery.....	6,000	14	28	"	

Results of trials at Pictou.

Of the coals named in the above list, that from the Foord pits appears to give the best result in gas-making, from its large gas-content, the high illuminating power of the gas, and the superior coke produced in its carbonization.

Value different coals.

The Drummond coal, and the coals of the Old mines, Dalhousie and Cage pits, appear to stand next, the value of the other coals for gas purposes falling slightly below these. The stellarite and oil-shale of the Acadia mines are most valuable for mixing with the coals, to increase their illuminating power, but would not be of great value if used alone, for two reasons: because their cokes are worthless, (being merely a cinder, with but a few per cent. of fixed carbon, and therefore useless in heating the retorts); and because the gases produced in carbonizing them are too carbonaceous for use with ordinary burners. Good coke is not only valuable to the gas-manufacturer as a merchantable product, but also is used for heating the retorts, and therefore cannels, and substances like torbanite, stellarite, and albertite, though producing a large amount of highly carburetted gas, are seldom used in gas-manufacture, except in mixture with coals furnishing a good coke.

I shall now proceed to give such facts as it has been possible to procure concerning the value of the different coals of this district in gas-manufac-

ture, some of which facts have already been published, while others have been obtained by correspondence, and in one case a special trial has been made at the Picton Gas-Works.

COALS OF THE ALBION MINES.

Albion-Mines coal.

The following extracts are from letters by Mr. George Buist, Manager and Chemist of the Halifax Gas Company, and Mr. W. W. Greenough, Manager of the Boston (Mass.) Gas Company, in answer to letters from myself, soliciting information for this Report. The companies represented by these gentlemen, have been for years large consumers of the Albion Mines coal.

LETTER OF MR. GEORGE BUIST.

(*Copy.*)

GAS OFFICE, HALIFAX, N.S., Feb. 24th, 1870.

Edward Hartley, Esq.,

DEAR SIR,—

I beg to acknowledge receipt of yours of 8th instant, making enquiries regarding Pictou coal.

Mr. Buist's letter.

I think the following statement may be taken as giving the correct quantities of the gas, coke and tar produced from one (1) ton of 2,240 lbs.

The quantity of gas will average about.....	7,300 cubic feet.
Illuminating power, about	15½ to 16 candles.
Weight of coke, about.....	1,450 lbs.
Quantity of coal-tar, about.....	9½ to 10 gallons.

The sulphur in the Pictou coal is very much less than in any of the other Nova Scotia coals. The quality of the coke is very good indeed. . . . .

I remain,

Yours truly,

(*Signed,*) GEORGE BUIST.

LETTER OF MR. W. W. GREENOUGH.

(*Copy.*)

OFFICE OF BOSTON GAS LIGHT COMPANY,
No. 20 West Street, Boston, Feb. 7th, 1870.

Edward Hartley, Esq.,

DEAR SIR,—

Your letter of inquiry of the 4th instant reached me . . . . . .

Mr. Greenough's letter.

We use the caking coals of Pictou and Cape Breton, in combination with richer coals. The proportions of these combinations are based upon experimental trials of each coal separately.

The best results in gas-making with the Pictou coals, are obtained by working the retorts at a cherry-red heat. One then gets from each ton of 2240 lbs., 7280 feet of gas—of *strong* 15-candle illuminating power, with a yield of 1325 lbs. of coke of fair quality. Higher heats will give more gas of an inferior grade, and with a diminished value of coke. This coal contains but a small proportion of sulphur compounds, is easily purified, and may be safely stored without danger from spontaneous combustion.*

. . . . . .

Yours truly,

(*Signed,*) W. W. GREENOUGH.

* The rest of this letter refers to Cape Breton coals, and need not be quoted here.

I would take this opportunity to thank Messrs. Buist and Greenough for the above facts, and for other valuable information they have kindly given me.

The statements in the following memorandum, sent me by Mr. Jas. Hudson, Chief Manager of the General Mining Association, are partially a repetition of the above facts:—

"Extract from letter of W. W. Greenough, Esq., Treasurer of Boston Gas Light Company, December, 1869.

"'We have made no recent analysis of gas made from Pictou coal, but the experience of several years working shews a uniform result:—with cherry-red heats, of 3¾ cubic feet to the pound, of 15-candle gas; with a condensation by bromine of 6.75; a specific gravity of 4.75; and the *smallest per centage of sulphuretted compounds of any coal called caking*. Coke fair. Higher heats will give more gas, at the expense of the illuminating power of the gas, and the quality of the coke.'"

McGREGOR COAL (ACADIA MINES).

McGregor coal.

The following statements are from the published report of Mr. Jesse Hoyt, Manager of the Acadia Coal Company, 1866:—

"On the 9th. of February, 1865, one ton of this coal, a mixture of both benches, was tested in the works of the Manhattan Gas Company, New York, with the following results:—

Trial at New York, U. S.

"'One ton of 2,240 lbs. yielded 9,500 feet of 13.03-candle gas, and 41 bushels of coke, weighing 1,640 lbs. The coke is good; it contains rather much ash, and makes some clinker, but it burns well, keeping up a good strong fire. The coal seems to deserve a trial on a larger scale, as it is very readily carbonized, yielding a good volume of gas and coke.'"

Analysis of the coal.

Volatile matter	32.0
Fixed carbon	59.3
Ash	8.7
	100.0

"A subsequent trial was made by the same company, but the result was not so favourable, as will appear by the following report:—

Second trial.

"'One ton of 2,240 lbs. yielded 9,500 feet of 13.34-candle gas, and 38 bushels of coke, weighing 1,744 lbs. The coke is poor; it clinkers badly, and does not keep up the fire under the retorts. It requires 4 bushels of lime to purify a ton.'"

Analysis of the coal.

Volatile matter	26.8
Fixed carbon	57.9
Ash	15.3
	100.0

Mr. Hoyt remarks that he believes the unfavourable result in the latter trial, to have been caused wholly by the admixture with the coal, of foreign matter from the *shale-band* or fire-clay parting, between the first and second benches of the McGregor seam.*

DRUMMOND COAL.

Drummond coal.

Through the kindness of Mr. Dunn, Manager of the Intercolonial Coal Company, I procured a special gas-trial of three coals, from the three upper divisions of the Acadia seam, as worked at the Drummond colliery.

This trial was made under the superintendence of Mr. Alexander Thompson, Engineer and Manager of the Pictou Gas Company, at their works. The samples were of two barrels each, and believed to be fair averages of the different benches. They were marked and numbered as follows:—

Special gas-trials.

Sample No. 1,—Top of seam, (2 feet 6 inches thick) left in the workings.
" No. 2,—From the fireclay *holing*, 2 feet up to the smooth parting. (Fall coal.)
" No. 3,—First bench. Below the *holing*, and 4 feet thick.

The numbers of these samples correspond to the numbers of the divisions and analyses of this seam at the Drummond colliery, in Section I. of this Report.

The following is a copy of Mr. Thompson's Report:—

(*Copy.*)

Mr. Thompson's Report.

GAS WORKS, PICTOU, N.S.
December 4th, 1869.

Edward Hartley, Esq.,
Geological Survey,

SIR,—

At your request I have carefully examined the contents of six (6) barrels of coal from the Drummond colliery, marked respectively Nos., 1, 2, and 3, with the following results:—

No. 1,—Yields at the rate of 7,000 cubic feet of gas and 32 bushels of coke to the ton.
No. 2,— " " " 7,500 " " " 32 " " "
No. 3,— " " " 8,500 " " " 36 " " "

The gas has an illuminating power of 15 candles. The volatile combustible matter is such in amount and character as to promise well in gas-making. The coke is firm and of good quality, well adapted for heating the retorts in gas-making, and can thus take the place of coal for that purpose.

I am, Sir,
Your obedient servant,
(*Signed,*) ALEX. THOMPSON,
Engineer and Manager.

Beside their use as steam and gas-producers, several Pictou coals are sold extensively for various other purposes, among which may be mentioned, re-heating iron, blacksmithing and domestic purposes. The cokes of one

* See Geological Report, Section 4, pp. 67-et seq., beds 71—73, See also page 96 of the same Report, and the first Section of this Report.

or two of the coals have also been, to a certain extent, successfully used in iron-smelting and founding. I am not at present able to furnish any exact data concerning the success with which they are used in rolling-mills etc., and no iron-smelting is at present carried on at any point near the Pictou district; but I am aware that in the Eastern United States, the coals are used in various forges and rolling, mills, with very good success, and I am assured by Mr. E. A. Jones, Manager of the Acadian Iron Works at Londonderry, Nova Scotia, that he has used Albion Mines coke in iron-smelting, and finds it better suited to this work than any other Provincial coal he has used.

For domestic purposes these coals are well and favourably known; they light easily in the grate and burn well and long with very little attention, except in the few cases where the content of ash is very large.

III.

IRON ORES OF PICTOU COUNTY.

Localities of iron ore.

A number of localities are known in the vicinity of the Pictou coal-field, where ores of iron have been found. None of these have ever been developed to any extent; and the few trial-pits upon the deposits, afford very unsatisfactory evidence as to their size and value. The ores of iron which have been recognized in this vicinity are; specular iron, limonite or brown hematite, and spathose ores (crystalline carbonates of iron); besides the clay-ironstone, or argillaceous carbonate of iron of the coal measures.

In the following paragraphs, mention is made of those localities only which I have personally examined, though a large number of others exist, of greater or less value. My field-work in this district was confined to the productive coal-field, except in the few cases where examinations beyond its boundaries were made at special request. The samples analysed, where no statements to the contrary are made, were taken by myself from the deposits, and are believed to be the averages of the ores. The analyses have been made in the laboratory of this Survey, by Mr. Broome.

SPECULAR IRON.

Specular iron

Several deposits of specular iron were examined; these all occurred in a range of metamorphic rocks lying ten or twelve miles to the south of the coal field. The ore of the variety known as micaceous iron ore, was noted at Battery Hill, near Glengarry station, and proceeding east from this point at a number of localities near the line of the Provincial Railway, the range of rocks including it finally crossing this railway and the East River of Pictou, several miles above Springville. Of the age of this for-

mation, I cannot speak with certainty, but it is probably Upper Silurian ; the rocks consist of quartzites, of light and dark green, purplish, brown and black colours, and slates highly altered, generally of a black colour and giving a white streak. The quartzites are sometimes coarsely granular, but as a rule, compact and fine grained. This formation appears quite distinct in lithological character from the series which has been described in the Reports of Sir William E. Logan and myself, as occuring near the Pictou coal field, at McLellan's and McGregor's Mountains, and at Waters' Hill, and which are believed by Dr. Dawson to be of Devonian age.

Age of including rocks.

I have made no attempt to obtain fossils in these rocks, nor has any bed been observed likely to contain them, at the few localities examined ; but it seems probable that the fossiliferous beds mentioned by Dr. Dawson in his Acadian Geology, (pages 568-570), as occurring near Springville, are included in this series. These beds, from which a large number of fossils have been collected by Mr. D. Frazer of Springville, are of undoubted Upper Silurian age.

Fossiliferous beds.

The specular iron appears to exist in true fissure-veins, but of no considerable size, at any locality which I have seen. In many cases the rocks holding it appear to be much shattered, and the specular iron, with a compact granular quartz as a veinstone, appears to fill the fissures, which are often confined to a particular bed of rock, and sometimes so numerous that the entire bed contains a large per centage of the ore, and may be considered as a single deposit. The most important deposit of this class which I have observed, occurs on the west side of the East Branch of the East River about three and a-half miles above Springville, on the lots of John McDonald and Archibald Thompson. Here the specular iron seems to exist over a considerable area, some portions being quite pure, but as the deposit is opened by two shallow pits only, it is impossible to state its size, or exact relations to the including rocks. The minor veins are often of several inches in thickness, and are included in a light greenish-drab granular quartzite, which they traverse in the most irregular manner. A sample of this ore was taken by me, which appeared to represent an average of what might be mined, provided all the larger lumps of quartzite taken out in mining were rejected. This sample gave on analysis :—

Character of the deposits.

Analysis.

Sesquioxide of iron	65.14
Silica	32.50
Hygroscopic moisture	.91
	98.50
Total amount of metallic iron ..... per cent.	45.60
Specific gravity	4.607

From the amount of silica present this ore would require a considerable amount of limestone as a flux, or it could be advantageously smelted

with a calcareous sparry iron ore like that used for mixture with hematites at the Acadian Iron Works at Londonderry. The locality is well worth a careful exploration, as the deposit seems continuous, and of a considerable width. It is, in common with many other of these deposits, easily traced upon the ground, from the bright rust colour of the soil, and the presence on the surface of a large amount of partially decomposed ore, or *gozzan*, which is easily recognised. The appearance of this substance is very deceptive to the inexperienced eye, and I have frequently had specimens of it brought to me, by parties who, from its uniform rust-red appearance, had been led to imagine it a very rich iron ore. Attention to its low specific gravity will often show how small an amount of iron it contains. The following is the result of a partial analysis of a sample of one of the best of these *gozzans* which I have seen. It was sent me from Rockland fulling-mills, on Middle River, by Mr. Robert Frazer, and in appearance was quite equal to some of the pure ochrey *gozzans* which are found in some other localities, but analysis shows it to be merely a porous mass of granular quartzite, deeply stained with iron-oxyd.

Gozzans from these deposits.

Analysis of a gozzan.

Sesquioxide of iron	25.48
Silica	62.61
Hygroscopic moisture	.81
Volatile at a red heat	4.43
	93.33
Amount of metallic iron ..... per cent.	17.84

The remaining constituents were lime, magnesia and manganese, which were not determined.

LIMONITE OR BROWN HEMATITE.

Limonite.

Numerous boulders of a very pure variety of limonite, have been found in the vicinity of Springville, on the East River, but so far as I can learn, the ore had not been found in place until Oct. 15th, 1868, when a bed was discovered, on James Frazer's land, about 1¾ miles above Springville, (on the east side of the East Branch of the East River), by Mr. A. P. Ross, of Pictou, and myself, while visiting the locality. The only exploration we were enabled to make, was a shallow pit, sunk in a few hours by one man, but this was sufficient to expose a mass eight feet in thickness, of a pure limonite of the mammillary, stalactitic, and fibrous varities. It was overlaid by a close grained altered sandstone or granular quartzite of a light greenish-gray colour, and appeared to be conformable to the stratification. The bottom of the bed was not exposed; it was hidden by a high drift bank; neither was the deposit traced for any

distance on the strike. Should it prove to be a persistent bed, it would be a most valuable deposit, as the ore is one of the purest known. No substance save the pure mineral was discovered in the bed, the roof appearing well defined.

The following analysis is of an average specimen taken by myself. It will be observed that the silicious residue does not equal half of one per cent :—

Analysis

Sesquioxide of iron	84.94
Combined water	15.43
Hygroscopic moisture	.92
Silica, (insoluble residue)	.41
	101.70
Amount of metallic iron per cent.	59.46

The rocks including this deposit appeared to belong to the same series as those further south, holding the specular iron deposits above described.

SPATHOSE ORES.

Spathose ore near Merigomish.

On the land of Neil McLaurin, about one and three-quarter miles south-west of Sutherland's bridge on Sutherland's river, a peculiar deposit of iron ore occurs, included in Indian-red and greenish-drab sandstones, apparently of the Millstone-Grit series. This ore, which I designate as spathose iron ore, appears to be a mixture of spathic iron, or crystalline carbonate of iron, and red hæmatite, or anhydrous peroxyd of iron, with but little impurity. The ore is seen in place, on the south bank of Sutherland's brook, where it is exposed by a number of costeening-pits, and it has also been traced for about 100 feet west of the point where it was first opened, the strike appearing to be very nearly E. and W., and the attitude nearly vertical.

Size of deposit

Whether this deposit should be considered a bed or a vein, is still a matter of uncertainty, but it appears to be comformable with the stratification. Its thickness, where exposed, varies from eleven to fourteen feet. Several attempts had been made to trace it farther westward at the time of my visit, but the pits sunk had failed to penetrate the drift. That this deposit, if found to be persistent, would be of considerable value, may be judged from the following analyses. No. 1 is of a specimen from the outcrop, on Sutherland's Brook, and No. 2, from a costeening pit, about 75 feet farther westward.

	E.	M.
Sesquioxide of iron	16.98	20.52
Carbonate of iron	65.61	57.40
Carbonate of manganese	7.98	8.29
Carbonate of lime	2.67	4.02
Carbonate of magnesia	3.23	5 66
Silica	3.76	2.38
Hygroscopic moisture	.78	1.43
Sulphur	none.	undet.
Phosphorus	.013	"
Organic matter	trace.	none.
	101.003	99.70
Amount of metallic iron	43.56	42.07

Dr. T. Sterry Hunt has kindly furnished me with the following note on these specimens:—

Dr. Hunt's opinion on the Spathose ore.

"The iron ores from Merigomish, Nova Scotia, consist of an admixture of red hæmatite and sparry carbonate of iron, with considerable manganese and but little lime, magnesia and silicious matter, and they appear, moreover, from the results of their analysis, to be remarkably free from sulphur and phosphorus. Their composition is such as to make them very readily reducible with a small amount of fuel in the blast furnace, while the presence of manganese, and their comparative freedom from sulphur and phosphorus, should make them peculiarly well fitted for the production of steel, either by puddling or by cementation."

CLAY-IRONSTONE.

Clay-ironstone.

A large number of bands of clay-ironstone were noted during my examination of the Pictou coal-field, but none of a size generally considered workable. Some thirty years ago, however, a cross-cut was driven by the General Mining Association upon the measures underlying the Main seam at the Albion mines, and several beds of ironstone were intersected. No reliable record remains of their size and quality, and the attempts which were then made to smelt them are known to have failed, but whether from mismanagement, or from the poor quality of the ore, is not certain.

At the present day these ores are better understood, and it would seem probable that some of these beds could be worked in connection with one of the seams, and smelted with some of the richer ores of the upper East River.

MONTREAL, P.Q., 22nd June, 1870. E. H.