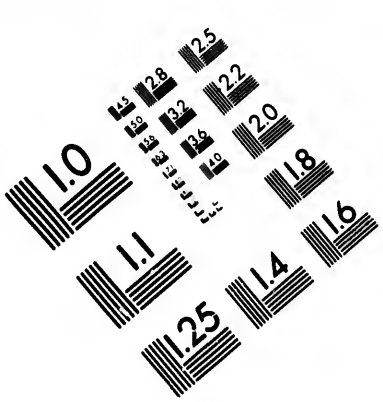

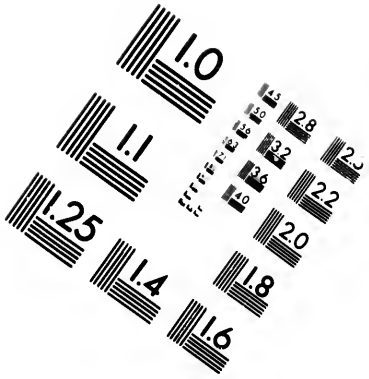

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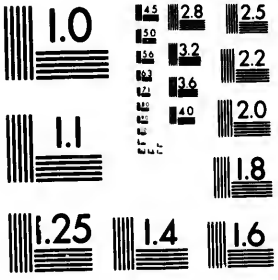

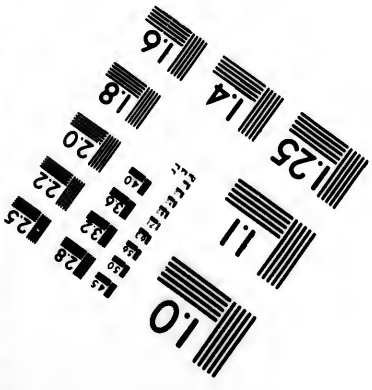

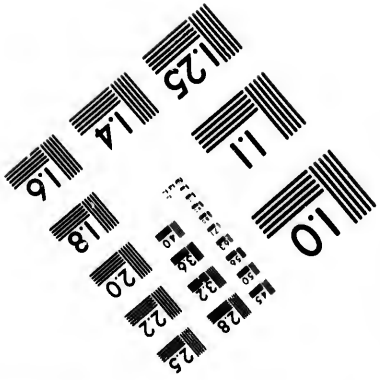

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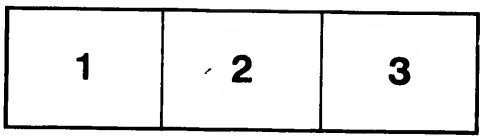

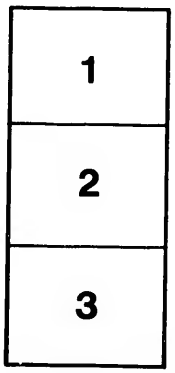

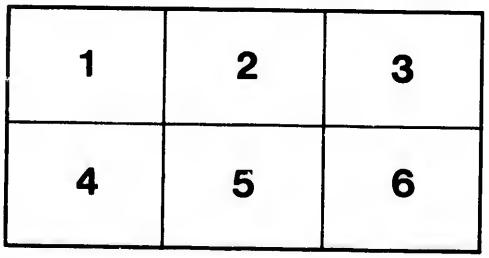

THE IRON ORES

OF

NOVA SCOTIA.

By EDWIN GILPIN, M.A., F.G.S.

BY PERMISSION OF THE COUNCIL.
EXCERPT MINUTES OF PROCEEDINGS OF THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS, VOL. XXVI., 1876.

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THE IRON ORES OF NOVA SCOTIA.

By EDWIN GILPIN, M.A., F.G.S.

In the following paper the writer purposes laying before the members, as concisely as possible, all the available information that he has been able to collect relative to the Nova Scotia Iron Ores. The geological ages, positions, extent, and qualities of the ores, are the chief points at present noticeable, the economic development being as yet limited.

The geological range of the best-known ores will be readily seen from the following table :—

Geological Age.		Variety of Ore Found.
Modern		B . ores.
Triassic trap		Magnetite. Red hematite.
Carboniferous.	Upper coal measures	Clay ironstone.
	True coal measures	Clay ironstone.
	Millstone grit	
	Lower carboniferous (marine formation)	Clay ironstone, spathic, red hematite, and limonite.
	Lower coal measures	
Devonian (Oriskany sandstone)		Specular and magnetite.
Upper silurian (Lower Helderberg) ...		Red hematite.
Upper silurian		Specular and magnetite of Pictou, limonite of Londonderry.
Lower silurian		Titaniferous and specular ore.

These ores form a broad band extending from end to end of the Province, and in the description, following the band from west to east, the ores will be noticed as they are successively met.

In the dykes and masses of trap associated with the triassic sandstones of the south side of the Bay of Fundy, are numerous veins and

pockets of magnetite and red hematite, probably not exceeding in any case one foot in thickness. The magnetite is generally very pure, the chief foreign ingredient being silica. It is usually massive, sometimes crystallised in partly filled veins, and associated with quartz, colourless and amethystine. Near Digby Neck, it is found with red hematite, and several hundred tons have been extracted for smelting.

The following analyses by Dr. H. How are of the common compact magnetite from two localities in the trap:—

	I.		I.
Quartz	5·46	... ...	4·94
Magnesia and traces of lime ...	1·27	... ...	4·84
Oxygen	24·94	... ...	25·19
Metallic iron	68·33	... ...	65·03

The magnetite also occurs disseminated where no ore is visible, and may be separated by means of a magnet from the powdered trap of several localities.

Red hematite is found at a number of places associated with agate, quartz, and calcite. It is sometimes presented in the form of small crystalline plates, in a granular quartz, matrix, and sometimes as crystals, apparently showing its derivation from magnetite. Much of the ore is decidedly magnetic, especially the more highly crystalline specimens.

This range of trap extends from Blomedon to Briar Island, a distance of 120 miles, and contains these ores everywhere in it; but as yet no veins have been found large enough to allow of systematic mining.

TITANIFEROUS IRON ORE.

This is found at St. Mary's Bay, west of Digby, as sand, forming bands of irregular extent in the beach. The indications are extensive, but no attempts have been made to test their value for working.

A sample yielded—

Magnetic ironsand, or iserine	30
Non-magnetic, or ilmenite	56
Silicious sand	14

both varieties containing a large amount of titanium and a little magnesia. This ore is reported from Shelburne, on the Atlantic coast, and from Musquodoboit, near Halifax; that from the latter place, being a dark grey micaceous schist, holding crystals of magnetite, with titanium in considerable quantity. The writer has also found an ore of similar appearance near Sutherland's River, Pictou Co., containing decided traces of titanium.

An attempt has been recently made to work titanic iron ore at Bay St. Paul, on the north shore of the Gulf of St. Lawrence. The ore containing about 36 per cent. of iron, 44 of titanic acid (and, according to Dr. Penny, no manganese, sulphur, or phosphorus), occurs as a bed about 90 feet thick in a rock of anorthosite of Hurouian age.

The dimensions of the furnaces are as follows :—

Height	30 feet
Diameter at hearth	4 „
Diameter at boshes	14 „
Diameter at throat	8 „

Each furnace has three tuyeres, the blast being heated by waste gas taken off by a cupped cone, and applied at a pressure of $1\frac{1}{2}$ lb. The fuel used was exclusively charcoal, 200 or 250 bushels being required for each ton of pig. The daily product of each furnace did not exceed five tons. The pig made was white and of fair quality; but the large amount of fuel used presented a formidable obstacle to profitable working. The following is an analysis of the pig by Mr. Edward Riley :—

Carbon	3·966
Silicon	·086
Sulphur	·030
Phosphorus	·253
Chromium	·689
Manganese } Titanium }	traces
Iron	95·245

The beneficial effects of titanium formerly dwelt upon are hardly borne out by practice, and it may perhaps be more justly regarded as a foreign ingredient that must be made to pass into the slag, thereby causing a loss of heat.

While in this connection, it may be stated that iron sand is found at various places along the Gulf of St. Lawrence, the Atlantic coast of Nova Scotia, and the west coast of Newfoundland, where in many places the iron sand is chiefly composed of magnetic ore.

The ores of Clementsport, near Annapolis, next claim attention. Here a narrow belt of strata of Devonian age, three to five miles wide, rises from under the Trias of the Annapolis Valley, and pursues an east and west course for about sixty miles. At one point it is divided by a mass of granite into two nearly equal portions. In the western division is the Clementsport, and in the eastern the Nictaux ores.

At Clementsport there are two beds of ore running nearly east and west, and underlying to the south* at angles of 75 to 80 degrees. The highest of these, the Milner bed, varies in thickness from two to four feet. It is specular ore metamorphosed with magnetic properties, and still retaining casts of virelebite, spirifers, and associated mollusks. The ore, which is of fair quality, yields about 33 per cent. of metallic iron. It is mined by open cast, and costs 6s. per ton for extraction.

The Potter bed is a magnetite, (?) and presents the following section where worked :—

	Ft.	In.
Ore	3	0
Slate	2	6
Ore	3	6
	9	0

It is compact, and of a dark grey colour. The writer has seen no analysis of it, but it is stated to yield 15 per cent. more iron than the Milner bed.

BLOOMFIELD BOG ORE.

This is found at several places in the vicinity of the above deposits, and yields 25 per cent. of iron. It occurs in layers six inches to two feet thick, covered by a few inches of soil. Considerable quantities of it have been extracted at a cost of 1s. 8d. per ton, for mixture with the other ores.

A blast-furnace was erected here about twenty years ago, and has been running since occasionally for a few months at a time. It is of similar dimensions to those built at Bay St. Paul, but $2\frac{1}{2}$ feet narrower at the boshes. The blast is supplied by a water-wheel through three tuyers, at a pressure of $1\frac{3}{4}$ to 2 lbs.

The blowing-cylinders are three in number, of cast iron, four feet in diameter, and four feet stroke. The blast is heated by burning the waste gas in an oven with seventeen syphon pipes. Mixtures of all the above ores are smelted, yielding an average of 35 per cent. of iron. 130 (Winchester) bushels of birch charcoal, costing $2\frac{1}{2}$d. to $3\frac{1}{4}$d. per bushel, are required to make one ton of grey pig. There are forty-five charges in twenty-four hours, consisting of from 750 to 800 lbs. ore, 120 lbs. limestone, and 16 bushels of charcoal, yielding daily about five tons. These ores cost at the furnace, including mining and hauling, two to four miles, from 4s. 3d. to 9s.

* The bearings, &c., in this paper are given relative to the astronomical north.

At Nictaux, 37 miles east of Clementsport, a furnace was built to work similar ores, but is now abandoned. The bed which was worked to supply the furnace is a highly fossiliferous peroxide of iron, associated with coarse dark slates, dipping S. 50 degrees E., at an angle of 60 degrees. It has been traced about four miles, and found to vary in thickness from three to four-and-a-half feet.

The fossils of the red hematite and associated beds are Spirifer arenosus, Strophemena depressa, Strophomena magnifica, Atrypa unguiformis, and species of Avicula, Bellerophon, Favosites and Zaphrentis, Tentaculites, and a coral considered by Mr. Billings identical with the Pleuro-dictyum problematicum, *Goldfuss*. These Professor Hall compares with the fauna of the Oriskany Sandstones, and they seem clearly to prove that these beds are of lower Devonian age.

The percentage of iron realised in working was about 50 per cent., but the amount of phosphorus present and the expense of transport were against the success of the enterprise. Purer ores are now known in the district, and it is intersected by a railway, so that the proposed resumption of smelting has more chance of succeeding.

There is a second deposit known here of grey magnetic ore, also of Devonian age. It is eight feet wide, and free from fossils; but, as the analyses show, still containing notable amounts of phosphorus.

	Magnetic.			Red Hematite.	
	I.	II.	III.	I.	II.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Metallic iron	50·09	54·22	59·11	58·05	57·93
Sulpur	·05	·069	·09	...	·036
Phosphorus	·79	·36	·17	·193	·16
Alumina	...	5·53	...	...	...
Lime	...	2·70	...	...	...
Magnesia...	...	·41	...	...	...
Silica	18·94	14·97	11·64	...	17·21

The ores of this district appear to have been originally red hematites or peroxides, but they have more or less lost part of their oxygen and become magnetic. Specimens can be got showing the gradual change from normal hematites, with cherry-red powder, to magnetic ores, with brown or black streaks. This is probably a local metamorphism, due to

the presence of organic matter and the granitic dykes which traverse the rocks in the vicinity.

From the country lying to the south of the Devonian above described, and extending to the east as far as Windsor, the writer has received specimens of red hematite, specular and bog ore. As yet, these ores are not known to exist in quantity, but as part of this district is underlaid by strata considered by Dr. Dawson and others equivalents of the ferriferous upper silurian beds of Arisaig and Pictou (to be described further on), there is a possibility of ores being found here in workable quantities.

At Goshen, between Windsor and Truro, a vein of ankerite containing limonite has been opened in strata of the marine limestone age, and proved to be 40 feet wide. The following analysis of the ore is interesting from the amount of manganese present. In connection with this ingredient, it may be stated that considerable quantities of manganite and pyrolusite have been mined and exported from this district.

Metallic iron	35·10
Oxides of manganese	24·74
Alumina	3·68
Lime...	·35
Magnesia	4·76
Silica	4·81
Iron pyrites	·20
Phosphoric acid	·21
Water	11·10
100 of iron contain...	·26 phosphorus.

At the mouth of the Subenacadie river, the lowest visible carboniferous bed is a dark laminated limestone, which, with the overlying sandstones and marls, contains small veins holding limonite and specular ore, with ankerite, barite, calcite, goethite, manganite, and siderite. In the same formation, a few miles to the eastward at Clifton, similar ores are found. At this point they are of more importance, one of the limonite veins being six feet wide.

At Brookfield, ten miles south of Truro, in measures of the same age, and near the contact of older strata, are extensive surface indications of limonite. A small trench shows a vein two feet wide in sandstone; further explorations might disclose a more valuable lode, as many of the boulders belong to a larger vein. This ore, from analyses by Dr. H. How, appears to be of unusual purity.

At North river, near Truro, a bed of magnetite has been opened in strata of upper silurian (?) age, and stated to be eight feet thick, and to contain 70 per cent., with mere traces of sulphur and phosphorus.

ACADIA MINES, LONDONDERRY.

The next to be noticed are these limonite deposits which are hardly equalled for extent, facility of access, and uniformity of quality. The Cobequid Hills, forming the division between the watersheds of the Gulf of St. Lawrence and the Basin of Minas, are an immense mass of upper and lower silurian strata, highly metamorphosed, and containing dykes of syenite.

The southern slope of these hills feeds numerous large brooks which have cut for themselves channels frequently 300 feet deep, and afford unusual facilities for tracing the ore as well as for studying its position. A good idea of its mode of occurrence may be gathered from the section exposed in the brook near the charcoal furnace. Here is a series of red and grey shales and sandstones of lower carboniferous age, dipping south at an angle of 60 degrees west, on vertical black and olive slates and quartzites of upper silurian age, striking north 31 degrees east. This line of contact has been traced about twelve miles along the hill sides or across the property of the company, and affords a key to the position of the ore vein, which is always found in the Silurian strata, at a distance varying from 300 or 500 yards from the lowest met carboniferous bed.

Another parallel vein is known one-half mile further north, but has not yet received attention, owing to the ample supply at present developed.

The vein rock consists of a mass of ankerite varying in width from 30 to 150 feet, and holding in places brecciated masses of quartzite and slate. The ore occurs in minor veins in the ankerite, and is found to be from 5 to 50 feet in width. The chief ore is limonite, which is found in the botryoidal, statactitic and compact form, but considerable quantities of micaceous hematite have been met.

The following are analyses of the two chief ores met :—

	Limonite.	Micaceous Hematite.
Peroxide of iron	82·65	96·93
Oxide of manganese... ...	·25	...
Alumina	·56	·33
Lime	·15	·04
Magnesia	·10	·11
Phosphoric acid	·38	·007
Sulphuric acid	·02	·03
Water, hydroscopic	·31	·05
Water, combined	10·51	·79
Insoluble	4·79	1·26
Metallic iron	57·85	67·85

100 of iron contain ·29 phosphorus.

The bed rock is an ankerite of brown and yellow colour, and is used as a flux. The following analysis is by Dr. H. How :—

Carbonate of lime	51·61
Carbonate of magnesia	28·69
Carbonate of iron	19·57
Insoluble	·13

The ore is won by levels driven to cut it at depths of 200 or 300 feet, and workings adapted to the shape and size of the deposits.

For many years this large body of ore supplied only a small charcoal furnace, from which about 35,000 tons of excellent pig have been made, the following analysis of which is by Tookey :—

Carbon	3·50
Silica	·84
Sulphur	·02
Phosphorus	·19
Manganese...	·44
Iron	94·85

The furnace is similar to that erected at Clementsport, already referred to, and is supplied with cold blast by means of a water-wheel.

The following are the amounts of ore, fuel, and flux used in August, 1873 :—

Ore—Limonite	421·3 tons.
Fuel—Charcoal	32,000·00 bushels (imperial.)
Flux—Ankerite	68·7 tons.
Pig iron made	221·00 tons, or 7·13 tons daily.

From which the following estimate may be made of the cost of a ton of pig :—

	s.	d.
2 tons of ore, at 9s. 7d.	19	2
⅓ ton flux, at 4s. 7d.	1	6
145 bushels charcoal, at 3¾d.	45	3
Labour and salary	10	5
General expenses	6	3
	82	7

The ore costs at the adit mouth about 5s., including dead work, and the expense of truckage from a distance of two or three miles, etc., would make its cost at the furnace as above.

Recently the property, embracing 50 square miles of freehold, has been purchased by a company of gentlemen, numbering among its direc-

tors Dr. Siemens, the Messrs. Tennant, of St. Rollux; A. O. Ewing, Esq., etc., who have nearly completed their arrangements for working it on a scale commensurate with its extent.

Two furnaces, equal to a weekly yield of 700 tons, and several Siemens' furnaces for the direct process have been erected at a point near the centre of the property, and connected by a branch line three miles long with the Intercolonial Railway. In addition, about nine miles of railway have been built to connect the furnaces with the chief openings on the ore.

The fuel to be used is the coke from the Albion Colliery working the main or 38 feet seam of the Pictou coal-field, of which the following is an analysis from the Report of the Inspector of Mines for 1875 :—

Carbon	83·88
Sulphur	·62
Ash	13·50
Moisture	·98 *

The results of the undertaking are awaited with much interest, as its success will not only prove beneficial to the province, but an encouragement to others interested in iron ores.

The Londonderry ores are known from surface indications to extend over twenty-five miles to the west of the lands controlled by this company, but no attempts have been made to prove their extent.

In the natural sections of the carboniferous measures exposed at the Joggins, are numerous balls and irregular bands of ironstone, not, however, yet considered of economic importance.

PICTOU COUNTY.—IRON ORES.

The iron ores of this district are more varied and of greater extent than elsewhere in the province, and from their relation to fuel, flux, and shipping, are destined to play an important part in its future development.

Although the existence of iron ores on the East River of Pictou was known for many years, it was not until 1872 that any systematic attempts were made to test their extent. As early as 1828, or shortly after the General Mining Association of London opened their Pictou collieries, a

* For comparison an average of four analyses of the Pennsylvania Cannelsville Coke which is considered the best in America, is subjoined :—

Carbon	85·24
Ash	12·30
Sulphur	·69
Phosphoric acid	·029
Moisture	·52

blast furnace was erected at the colliery, and a small quantity of red hematite and limonite smelted; but the expense of hauling the ore twelve miles soon put an end to the work. Nothing was then done until, in 1872–3, extensive explorations were carried on under the supervision of Dr. Dawson, and continued from that date by the writer.

The accompanying maps (Plates VIII. and IX.) will show the geological formation of the district, and the chief outcrops of ore. They are tolerably correct where defining the boundaries of the coal-field, and the contact of the carboniferous and silurian.* The other lines may be regarded as approximately correct, but as yet the writer knows no distinct change of life or strata dividing the millstone grit and lower carboniferous of this district.

Taking the ores in descending geological order, the first to be noticed are the clay ironstone bands of the Pictou coal-field. From sinking records they appear to form bands from 6 to 30 inches thick. Little attention has as yet been paid to them, and no analysis has been obtained by the writer, but it is considered that their quality is sufficiently good to render them an important addition to the older ones.

At French river, in the marine limestone formation (?) are numerous beds of clay ironstone, carbonates, and hydrated peroxides, in beds from six inches to four feet in thickness, with a breadth of outcrop of about one mile. As they are as yet only exposed on the French river, and the measures are undulating, part of the width of outcrop may prove a repetition. The discovery is a recent one, and little is yet known about the deposits. From assays of several samples, a percentage of 25 to 30 of metallic iron has been obtained.

Passing to the westward a large deposit of spathic ore is found at Sutherland's Brook, held by the Pictou Coal and Iron Co. The containing strata were formerly considered of millstone grit age; but, from the proximity of gypsum and limestone, they would seem rather to belong to the marine limestone formation. As far as can be judged from a rough survey, this ore is found at a horizon 800 feet lower than the ironstone of French river.

The bed dips south at an angle of 60 degrees, and varies in thickness from 6 to 10½ feet, and has above and below a small bed of the same 6 to 10 inches thick. The ore is a sparry carbonate of iron, holding peroxide in places, with a variable proportion of manganese, and very little sulphur and phosphorus. Superficially it is rusted, but where unweathered of a pearly grey colour.

* Until recently considered of Devonian age.

ANALYSES OF SPATHIC ORE.

	I. Dr. S. Hunt.	II. T. E. Thorpe.
Sesquioxide of iron	20·52 ...	...
Carbonate of iron	57·40 ...	88·59
Carbonate of manganese... ...	8·29 ...	2·85
Carbonate of lime	4·02 ...	1·53
Carbonate of magnesia	5·66 ...	3·48
Silica	2·38 ...	2·70
Moisture	1·43 ...	$\left\{\begin{matrix}\text{Ca SO}_4 \\ \cdot 55\end{matrix}\right.$
Sulphur	None ...	...
Phosphorus	None ...	...
Iron	42·07 ...	42·76

From the map (Plate VIII.) it will appear that, from Springwell for several miles up the East River, the line of contact of the marine limestone and silurian follows closely the course of the river. At several points along this line a very fine deposit of limonite has been proved. On the property of the Halifax Co., some years ago, the writer proved it to have a thickness of 21 feet 6 inches, and recent researches have proved a width of 15 feet on the Saddler area of the Picton Coal and Iron Co.

The ore is compact, concretionary, and fibrous, with considerable quantities of gravel ore. At two points the ore has been proved to rest on the silurian clay slates, and has limestone on the hanging wall, usually with a gore of red clay, frequently holding concretions of manganite and pyrolusite intervening. These ores are very pure, and appear to be much more free from phosphorus than the Londonderry limonite, the average of five analyses giving ·118 phosphoric acid, or ·083 of phosphorus, in 100 parts of iron.

The belt holding ore is 800 yards wide at several places, as shown by surface indications, and it appears probable that there is a large amount of it in the valley.

The limonite may have been derived, like the limonite of Cumberland Co. and other localities in Pennsylvania, as a residual precipitate from the disseminated iron sand grains of the upper silurian strata, as well as a deposit from the gradual dissolution of the marine limestones. In view of this, it may be stated that in this district the rocks of both ages contain considerable quantities of iron as carbonate and peroxide, and that the erosion has been on an enormous scale, as shown by the section taken along the line A to B, Plate VIII., extended in section in Plate X. (For analysis see Table, page 84.)

The district extending from the Sunny Brae nearly to the spathic ore in Sutherland's Brook, is occupied by grey and brownish quartzites, olive and grey slates with calcareous bands, usually coarse and unevenly bedded,

and containing the fossils of the Arisaig group, a series considered equivalent to the lower Helderberg of American geologists, and perhaps in its specific forms more related to the English Ludlow. The following are among the more common fossils of this district :—Favosites, Zaphrentis, Chonetes tenuistriata, Spirifer rugœcosta, Strophomena profunda, Rhynchonella spirata, Atrypa reticularis, Athyris didyma, Megambonia striata, trilobata, Orthoceras sev. sp., Cornulites, Dalmania Logani, etc.

The chief ore of this formation is a bedded red hematite found in four principal deposits. The most northerly of these is known as the McKenzie red hematite. It appears from surface indications to be of large size, but no work has yet been done to test it.

The next bed, known as the Webster ore, has been carefully trenched and tested at several points. Its thickness varies from 15 to 30 feet, its dip being generally north at angles varying from 25 to 60 degrees.

At two points it presents the following sections :—

	Ft.	In.
Ore	4	4
Smooth parting	0	0
Ore	3	0
Slate	2	11
Ore	3	3
Total	13	6

	Ft.	In.
Ore (in four layers)	5	0
Smooth parting	0	0
Ore	2	6
Smooth parting	0	0
Ore	3	0
Slaty ore	3	10
Ore	6	0
Total	20	4

This ore follows the crest of a high hill, cut transversely by the valley of Sutherland's river, and admits of adit drainage to a depth of 300 feet. The ore is compact, non-fossiliferous, and brick-red when weathered.

The third exposure is known as the Blanchard great bed. No attempts have yet been made to trace it beyond the natural exposures which extend about half a mile. It varies in width from 30 to 100 feet, measured across a dip nearly vertical. It is also situated on elevated ground, and would yield a large amount of ore.

At a geological horizon about 700 feet higher than the last-mentioned bed, is a conformable range of red hematites forming the fourth series. This ore appears as shown on the map to form a synclinal trough. On the west side the ore is 12 feet thick, and at the apex there appear the outcrops of two other beds eight and three feet in thickness, the larger possibly representing the great bed. On the east side of the synclinal, only one bed has been opened, varying in width from three to five feet. Underlying this bed, and on the line where the great bed would show its eastern outcrop, are large boulders, precisely similar in appearance to the one on its western outcrop, and it is expected that it will shortly be found here.

It is considered by some geologists that the three large single beds were originally one, and owe their present disjointed condition to faults and erosion; no detailed survey, however, has been made to prove the correctness of this opinion, and at present it can only be said that they are apparently contained in a limited vertical range of strata.

The outcrops of other red hematites have been marked on the map, but no work has been done to allow of details.

These red hematites are all of the same class, being of a red colour, with earthy to steely lustre, compact or laminated, sometimes oolitic, owing to the peroxide forming minute concretions around grains of sand. In places these ores contain fossils, but the larger proportion are quite free from them. (For analyses see Table, page 84.) They are excellently adapted for mining, being on high ground, with good roof, and requiring little or no dead work.

Similar ores, called fossil red hematites, are found in Pennsylvania, in strata of the Clinton age, and extensively worked near Tyrone, for mixture with rich hematites and magnetites. For comparison, an analysis of one is given, made at the University of Pennsylvania :—

Sesquioxide of iron	38·48
Peroxide of iron	4·37
Silica	37·99
Alumina	9·56
Lime	1·08
Alkalies	2·89
Phosphoric acid	1·48
Sulphur	trace
Volatile	4·50
Metallic iron	30·34

Passing to the west side of the East River is found the carboniferous, resting on a broad belt of black and olive slate, with bands of quartzite dipping almost vertically to the south. In these measures, considered by Dr. Dawson the equivalents of those holding the Londonderry ores, is a large vein of specular—or rather micaceous iron ore. The exact relation of these measures to those holding the red hematites is not easily ascertained, as no fossils have yet been found in them, but they appear to underlie them. The vein shows ore varying in width from 5 to 20 feet; in places there are intercalated masses of quartzite and ankerite. The Pictou Coal and Iron Company own over two miles of this vein, in addition to large and well-selected areas in the Webster and other red hematites on the east side of the river.

At two points, a side vein, of a mixture of specular and magnetic ore,

one to two feet thick, has been met, but no work has been done to test its value.

The main vein is cut by several ravines, and for some distance runs close to the brow of a hill about 200 feet high, which would be found advantageous in mining. (For analyses see Table below.)

About two-and-a-half miles to the westward, and nearly on the strike of the specular ore, an immense mass of reddish quartzite is found in similar black slates, and holds several veins of limonite, from one to three feet in thickness. The bed rock has been traced some distance, and is capable of yielding a considerable quantity of ore above water-level. The ore is compact, of a chocolate-brown colour, with small cavities lined with crystals, and smooth plates of the same mineral.

Near Glengarry, specular ore is again met in small veins, in a yellowish grey quartzite, but no work has been done to test its extent.

At numerous other points in the county, rocks of silurian and carboniferous age, and some of the traps, contain crystals and veinlets of specular and magnetic ore, as traces of metamorphic action, as well as indications of permanent deposits; but little attention has been paid to them beyond the district described.

ANALYSES OF PICTOU IRON ORES.

	Specular.		Limonite.		Red Hematite.	
	I.	II.	III.	IV.	V.	VI.
Oxides of iron	Per Cent. 92·01	Per Cent. 97·52	Per Cent. 93·09	Per Cent. 81·19	Per Cent. 70·00	Per Cent. 65·26
„ magnesia ...	2·16	...	1·10	·20	...	trace
Alumina	·21	...	...	...	...	5·59
Carbonate of lime ...	1·27	...	·91	·63	3·03	1·88
„ magnesia	·43	...	...	...	...	1·05
Phosphoric acid ...	·08	...	...	·15	·20	...
Sulphur	·16	·06	·04	trace	...	...
Silica	3·68	3·20	4·80	4·26	25·82	25·68
Metallic Iron	64·41	68·33	65·20	56·83	45·47	43·4
Phosphorus in 100 parts of iron ...	·054	...	...	·11	·19	...

I.—Dr. Macadam. II., III., VI.—Dr. T. E. Thorpe. IV., V.—J. H. Huxley, Sheffield.

At Arisaig, in highly metamorphic upper silurian strata, a bed of red hematite, three feet wide, has been opened. From specimens that the writer

has seen, it appears similar in character to the bedded hematites just described. This bed is found at the eastern extremity of the Lower Helderberg strata already noticed, and in the long range intervening new discoveries may be confidently expected.

CAPE BRETON.

Knowledge of the iron ores of this part of the province is limited, no work having been done beyond a few trenches across the outcrops of what appear to be promising deposits.

At Loraine, near Louisberg, boulders of a compact red hematite, of excellent quality, have been found; but the writer is not aware of any attempts to prove the ore *in situ*. The following is an analysis of it by Mr. G. F. Downing, of Workington :—

Peroxide of iron	90·14
Lime and magnesia	4·20
Sulphur	·10
Phosphoric acid	·11
Silica	5·45
Phosphorus in 100 parts of iron	·054

This ore resembles some of the Cumberland (England) red hematites in appearance and quality.

Near the summit of the lower carboniferous, as exposed near Sydney, is a thick bed of red marl, with nodules of limestone. Near the top of this bed is a hard grey sandstone, containing a variable amount of peroxide of iron in places, equal to 30 per cent. of metallic iron. Attempts to work this ore proved unsuccessful, owing to its irregular quality and distribution.

At Big Pond, on the Bras d'Or Lake, a bed of red hematite, about eight feet thick, has been traced about 700 yards. It occurs in hard felsitic rocks, associated with soft micaceous and steatitic slates, considered by the Geological Survey of Canada to be of Huronian age(?) According to Dr. How, of Windsor, the ore contains 61·39 per cent. of iron, 9 per cent. of silica, and mere traces of sulphur and phosphorus. On the opposite side of East Bay similar ore has been found.

At Whyhogomah, in rocks of upper silurian age, no less than nine deposits have been exposed and traced a few hundred yards; from surface indications they appear to extend much further. One bed of magnetite is nine feet thick, and another of red hematite six feet. The former, on analysis by the officers of the Geological Survey, was found to consist of a mixture of specular and magnetic ore, with a considerable quantity of silicious matter, and gave 42·64 per cent. metallic iron, and ·26 per cent.

of phosphoric acid. The latter gave, it is stated, 56 per cent. of iron. These deposits, being on elevated ground, and only a quarter of a mile from shipping, are well situated for working. Clay ironstone is found in nodules and thin beds at several localities in the Cape Breton coal measures, but is not yet proved to be of economic value.

When the lack of interest, the want of information, and the thinly settled state of the province are considered, it is thought the discoveries made promise well for the future. As the country gets more settled, fresh discoveries may be anticipated, for nearly all of the ores mentioned above were disclosed by the plough or natural exposures, and as the greater part of the province likely to contain ore is wooded, there will probably be no future deficiency of the raw material.

LIST OF LOCALITIES CONTAINING IRON ORE.

Locality.	Geological Age.	Variety of Ore.	Metallic Per-centage.	Remarks.
Newton Mills, Stewiacke	Lower Carboniferous	Limonite ...	...	
Lochaber ...	Upper Silurian	Specular Spathic	...	Found in thin veins and as matrix of copper ores.
St. Mary River	Lower Carboniferous?	Limonite Clay Ironstone	...	Known only from extensive surface indications.
West Branch Lake	Upper Silurian	Limonite ...	...	Crystalline in small veins.
New Glasgow	Upper Coal Measures	Clay Ironstone	30·55	Quantity considered small.
Green Hill ...	Ditto	Limonite ...	...	Vein said to be 6 in. thick.
Merigomish ...	Lower Carboniferous	Red Hematite	...	Compact, as pebbles in conglomerate, resting on silurian strata
Antigonishe...	... ...	Bog Ore ...	45·00	
Guysboro' ...	Lower Carboniferous	Specular ...	60·00	
Cape Breton—Mabou	Coal Measures	Clay Ironstone	42·00	Quantity considered small.
Loch Lomond	... ...	Manganiferous Limonite	...	
Sydney (Town)	Lower Carboniferous	Clay Ironstone	...	Ditto.
Barrasois ...	Coal Measures	Ditto	27 89	Ditto.
Schooner Pond	Ditto	Bog Ore Clay Ironstone	35·00 25·84	Ditto.
P. E. Island—Gallas Point	Upper Coal Measures	Nodular Red Hematite	...	Quantity considerable.

LIMESTONES.

Little is yet known of the character and composition of the Nova Scotia limestones. They are principally confined to the lower carboniferous main formation, and, as shown on the map, have a wide range over the province. A few beds have been quarried to a small degree for lime, but nothing is known of their extent, operations having been confined to the crop.

Their qualities, judging from their physical properties, are as varied as their extent and number; some being arenaceous or argillaceous, others bituminous, with from 2 to 3 per cent. of phosphoric acid; these latter being from the lower or false coal-measures, and some are quarried for building and ornamental purposes.

At Windsor, Subenacadie, and Antigonishe, the outcrops of numerous beds are known. On the East River of Pictou, they are, as already mentioned, associated with the iron ores, and very abundant. In a survey of the limestone band, made by the writer in 1875, he noted the crops of over fifty beds, varying in thickness from 2 to 30 feet.

ANALYSES OF LIMESTONE.

	Nova Scotia.				Cape Breton.
	East River.	East River.	Windsor.	Antigonishe.	Marble Mt.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Carbonate of lime	93·03	96·26	97·64	74·64	94·31
„ magnesia	2·45	2·33	1·10	4·84	·75
Oxide of manganese	·59	·57	...	...	...
„ iron and alumina ...	·71	·55	·07	5·05	·45
Sulphur	·03	·10	...	..	...
Phosphorus	·03	·02	...	...	trace
Silica	2·10	1·99	·68	13·82	·16
Moisture	·18	·17	...	·16	·14

CONDITIONS UPON WHICH MINERAL LANDS ARE GRANTED.

The following is a brief outline of the conditions under which mineral lands are granted by the Provincial Government to those desirous of opening mines :—

Up to the year 1809 all lands were granted with the iron ores they

contained; after that date iron ore, coal, and other minerals, were reserved to the Crown, and after the year 1858 were granted as a source of revenue under the following conditions:—

Upon payment of £4 a license is granted to search for minerals over a space of five square miles during one year; upon a further payment of £4 this license can be extended another year.

Before the expiry of the license to search, a right to work, extending over one square mile, can be selected out of the license to search. This right to work, not exceeding two and one-half miles in length, costs £10, and lasts two years, and may be extended one year by payment of £5.

During the right to work, if *bona-fide* mining operations have been commenced and carried on, the holder of the right to work will be entitled to a lease of the one square mile for twenty years on payment of £6, which lease is again renewable.

The Crown also requires a small royalty of three cents, or about one penny farthing, on every ton of iron ore, of two thousand pounds, that is extracted.

The law further provides that parties exploring and working mines can take, under arbitration, all land required for mining purposes.

It will appear from the above outline that mineral properties are acquired in this province under reasonable conditions, and the mining law is framed with the view of affording the mineral explorer every legitimate assistance.

Mr. JOHN DAGLISH thought it would be very difficult to follow a paper of that kind when just hearing it read. It was a paper containing much matter for consideration and reference. There was, however, just one observation which struck him in passing, and which had a general interest, and that was where the writer spoke of the passage of hematite into magnetite ore by deoxidization. He had had an opportunity, near Lisbon, in Portugal, of investigating extensive adjacent mines of magnetite and brown hematite, but in no case was there any red hematite. The reason given by the writer for the deoxidization of the ores, on the face of it, carried apparent reason; and the same arguments were sometimes used as to the formation of hematites in the first instance, viz., that they were carbonated to begin with. In Lincolnshire, it is stated that the carbonate there passed into oxides at the outcrop.

The CHAIRMAN—Mr. Gilpin speaks of it as a probable local meta-

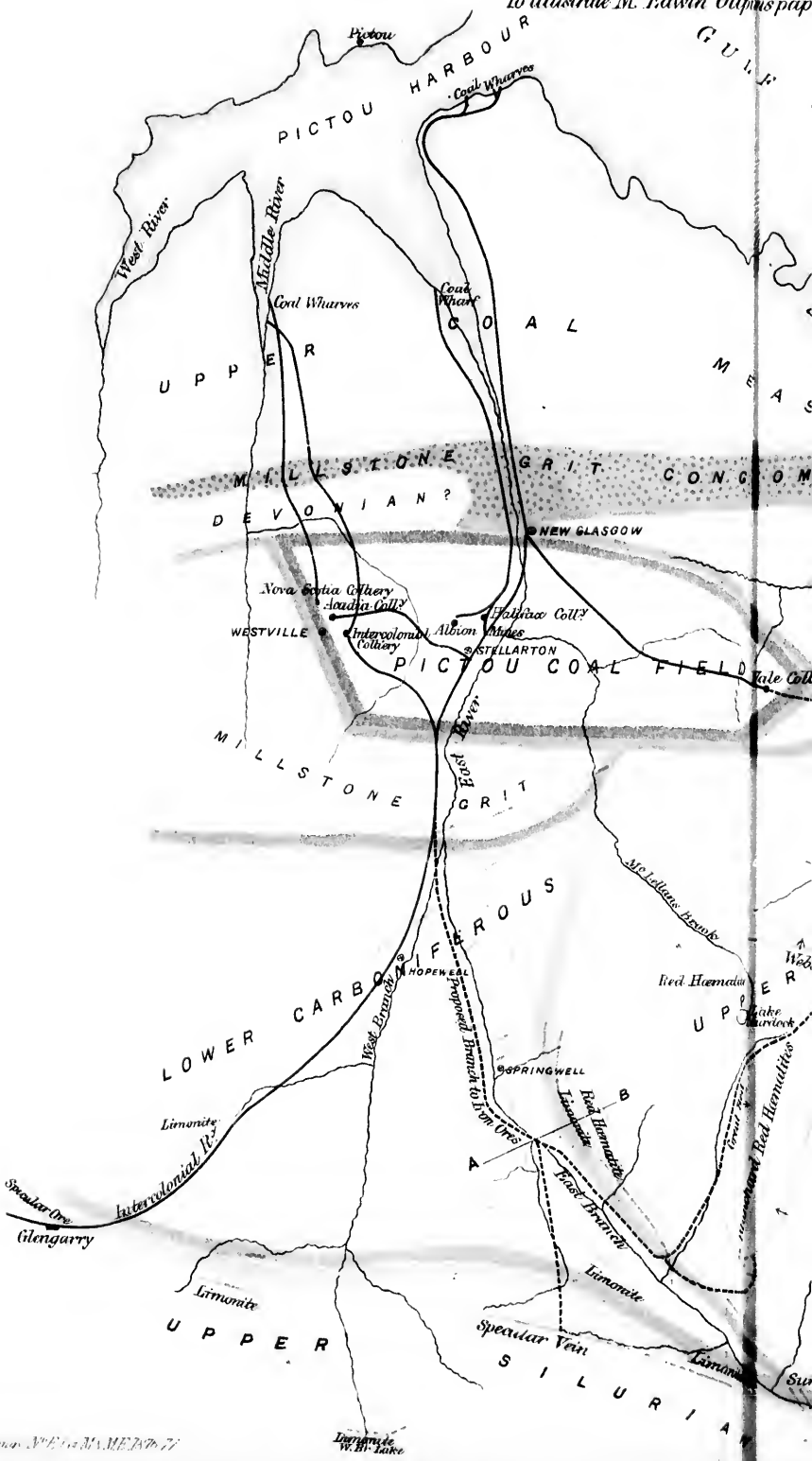
morphism. He knew the ores to which Mr. Daglish alluded, but did not know of any red hematites in Portugal. Magnetites and red hematites are not generally found together.

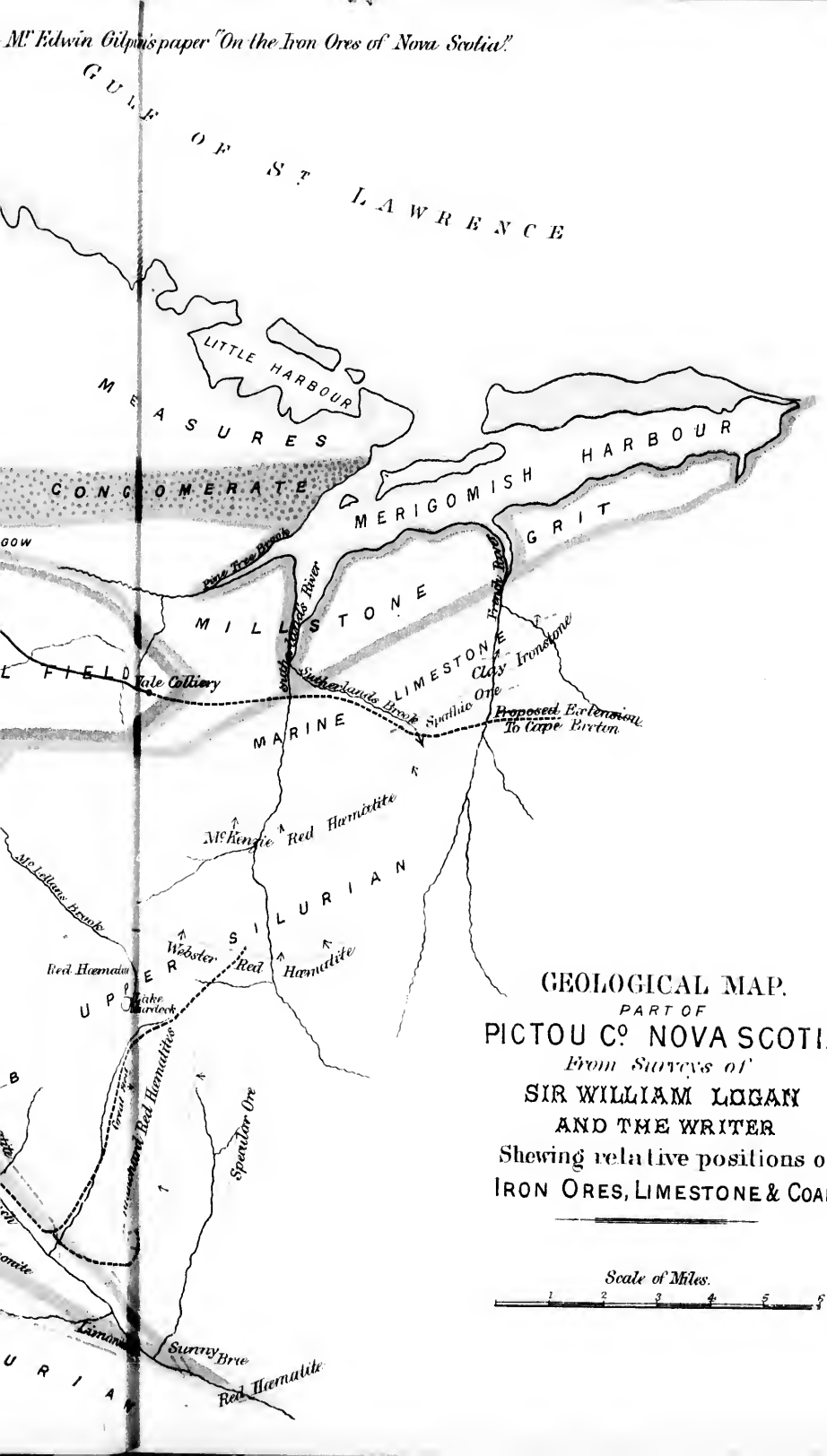
Mr. BUNNING said there was one drawback to these papers which were written by gentlemen who reside at a great distance from the Institute; the authors were not able to answer any question which might be asked. He thought this inconvenience could be very much remedied if, after the paper was in the hands of the members, any member who might have any question to ask, or remark to make, would write to him a letter containing those questions or remarks, and he would enclose the substance of the letters to the writer of the paper, and hear what further observations he had to make, and this correspondence might be condensed into a sort of discussion, and published with the Transactions.

The CHAIRMAN approved of the remarks of Mr. Bunning. It had occurred to him that day, on looking over the paper, that the difficulty which the Secretary had mentioned would arise, inasmuch as there were several points upon which he should like to ask questions; but as the author was not present, and no one to represent him, it was of course impossible to get them answered; it would be well to carry out the suggestion of the Secretary. The paper contained much valuable information as regards iron ores, and a part of it had reference to limestone. From the paper it appears that there are really some valuable deposits of iron ore in Nova Scotia. It would be interesting if Mr. Gilpin were to send some specimens, especially of the ores referred to by Mr. Daglish. Communications of this character would be more interesting if writers of papers generally forwarded specimens of the minerals alluded to in their respective papers. He begged to propose a vote of thanks to the writer.

A vote of thanks having been carried by acclamation, the meeting separated.

To illustrate Mr Edwin Gilpin's pap





GEOLOGICAL MAP.

PART OF

PICTOU Cº NOVA SCOTIA;

From Surveys of

SIR WILLIAM LOGAN

AND THE WRITER

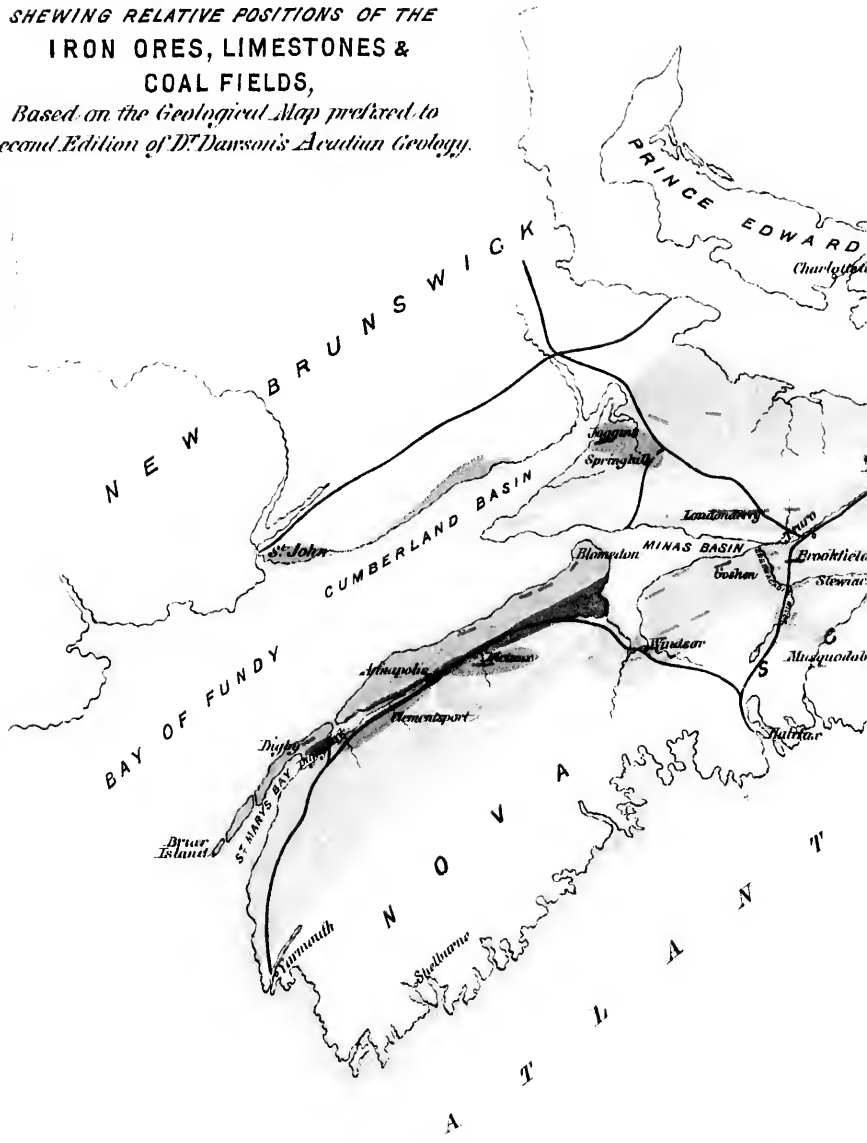
Shewing relative positions of

IRON ORES, LIMESTONE & COAL.

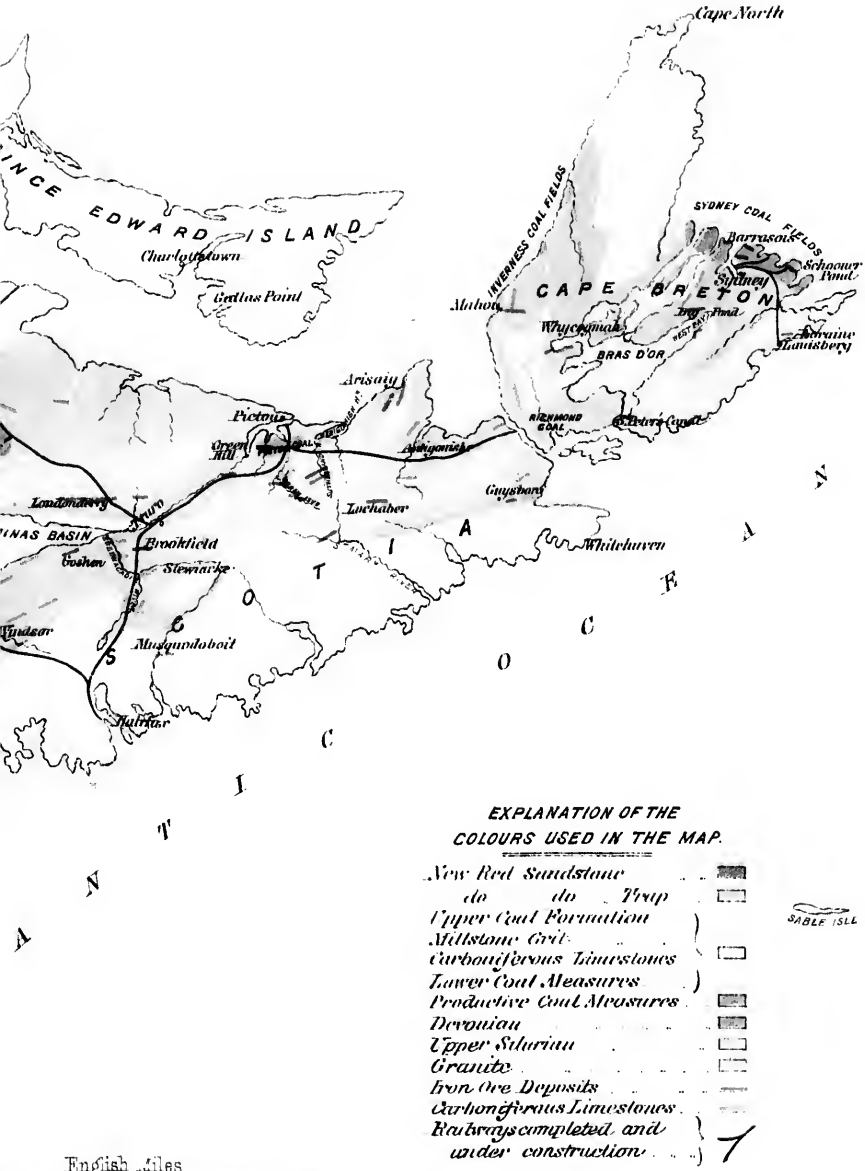
Scale of Miles.

1 2 3 4 5 6

GEOLOGICAL MAP
OF
NOVA SCOTIA,
SHEWING RELATIVE POSITIONS OF THE
IRON ORES, LIMESTONES &
COAL FIELDS,
Based on the Geological Map prefixed to
Second Edition of Dr. Dawson's Acadian Geology.



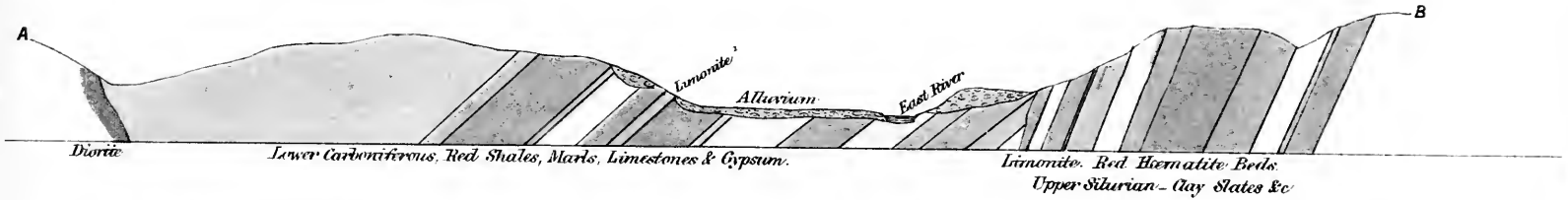
Gilpin's paper "On the Iron Ores of Nova Scotia".



Ap[r] Read Newcastle

To illustrate Mr Edwin Gilpin's paper "On the Iron Ores of Nova Scotia"

To illustrate Mr. Edwin Gilpin's paper "On the Iron Ores of Nova Scotia".



Section across East River Iron Ore, showing Erosion and Contact Vein of Limonite, with Limestone and Gypsum on one side and Silurian Clay Slates forming foot wall.

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