
MAP OF
THE PROVINCE OF
NOVA SCOTIA
Showing distribution of occurrences of
Limestone, Iron Ore, and Coal Fields.
Scale of Miles
LEGEND.
Iron
Dolomitic Limestone (pre-Cambrian)
Limestone (Cambrian and younger)
Permian overlying coal basin of Cumberland County
Coal Measures (including undifferentiated Millstone Grit in Inverness and Richmond Counties)
Millstone Grit, Cape Breton County
NEW BRUNSWICK
BAY OF FUNDY
CHIGNECTO CHANNEL
MINAS CHANNEL
BASIN OF MINAS
COBEQUID BAY
ST MARY'S BAY
GEORGE BAY
CHEDABUCTO BAY
GREAT BRAS D'OR LAKE
ATLANTIC OCEAN
PICTOU IS
AMHERST
PARRSBORO
TRURO
PICTOU
ANTIGONISH HARBOR
PORT MULGRAVE
GUYSBORO
HALIFAX
SHUBENACADIE
WINDSOR
KENTVILLE
ANNAPOLIS
DIGBY
WEYMOUTH
YARMOUTH
SHELBURNE
LIVERPOOL
BRIDGEWATER
LUNENBURG
MAHONE BAY
TATAMAGOUCHE BAY
BAY VERTE
PUGWASH
CAPE ST GEORGE
ARISAIG DISTRICT
TOR BAY
Cape Canso
C. North
ASPY BAY
C. Egmont
ST ANNS BAY
GREAT BRAS D'OR
LITTLE BRAS D'OR
Sydney Harbor
Glace Bay
Port Morien
MIRA BAY
SCATARI IS
C. Breton
LOUISBURG
Bay of Rocks
WEST BAY
EAST BAY
ST ANDREWS CHANNEL
Halifax Harbor
Seal Is
LAKE ROSSIGNOL
C. Blomidon
C. Split
SCOTTS BAY
GREVILLE BAY
ADVOCATE BAY
C. Chignecto
Long Island
Digby Neck
66°
65°
64°
63°
62°
61°
60°
47°
46°
45°
44°
A. S. Jost

CANADA
DEPARTMENT OF MINES
MINES BRANCH

HON. W. TEMPLEMAN, MINISTER; A. P. LOW, LL.D., DEPUTY MINISTER;
EUGENE HAANEL, PH. D., DIRECTOR.

REPORT

ON THE

IRON ORE DEPOSITS

OF

NOVA SCOTIA

(PART I)

BY

J. E. WOODMAN, A.M., Sc.D., (HARV.),
F.G.S.A., M.A.I.M.E.

OTTAWA
GOVERNMENT PRINTING BUREAU
1909

No. 20.

LETTER OF TRANSMITTAL.

DR. EUGENE HAANEL,
Director of Mines Branch,
Dept. of Mines,
Ottawa.

HALIFAX, NOVA SCOTIA,
September 1st, 1907.

SIR,—I beg to submit a paper, "Report upon Iron Ores of Nova Scotia," prepared in accordance with a Letter of Instructions received from you under date of 26th of May, 1906, and subsequent correspondence. This letter is as follows:—

"OTTAWA, 26th May, 1906.

DEAR SIR,—You are hereby instructed to make as complete investigations as possible of all important iron ore deposits so far discovered in Nova Scotia. It is desirable that deposits which are favorably located as regards transportation be taken first.

The information desired is to be of such a character as will aid the development of the iron industry in Canada. Geological features are to be considered only in so far as they may be necessary for a comprehension of the nature of the ore deposits.

It may be advisable at some future date to make magnetic surveys of the more important magnetite deposits and for this purpose it will be necessary that in your report you point out deposits which should be examined by the magnetometric method, stating whether the ore field is fairly level or comprises a difficult terrain.

The following are the points to which attention should be paid:—

1st—Localities of iron ore deposits so far discovered, and names and addresses of owners.

2nd—History of development of mines and companies (if any).

3rd—Geological description.

4th—Analyses of ores.

5th—In case of mines which have been worked, output and statistics.

6th—Transportation facilities.

7th—Limestone in neighborhood of deposits.

8th—State in general terms character of forest in neighborhood, *i.e.*, whether the supply is sufficient for mining purposes and for the production of charcoal in the event of the introduction of electric smelting.

9th—Maps of mines (and drill holes, if any).

The report is to furnish as complete a survey of the iron ore deposits of Nova Scotia as the field work planned for the summer will permit.

You are further instructed to organize your field party at the earliest date and proceed to carry out the work as outlined above.

Yours truly,

(Signed) EUGENE HAANEL,
Superintendent of Mines."

PROFESSOR J. E. WOODMAN,

Work began immediately upon receipt of orders, and continued until stopped by the inclemency of the late autumn. A few points left unfinished were cleared up in the spring of 1907.

So far as has been possible, all instructions as to scope and character of work have been carried out to the letter.

The general nature of this work and its limitations are discussed in the introduction. As it has been impossible to cover the whole field in one season, the present report is labelled VOLUME I.

I have the honor to be, Sir,

Your obedient servant,

J. EDMUND WOODMAN.

Geological Laboratories,
Dalhousie University.

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REPORT

ON THE

IRON ORE DEPOSITS OF NOVA SCOTIA

BY

Dr. J. E. Woodman.

INTRODUCTION.

The iron ores of Nova Scotia have been touched upon so often in geological literature that, if a bibliography of the references were to be made, it would appear that there is no room for further work. With the exception of a few papers, however, no attempt has been made to give detailed accounts of any of the ore deposits; and the casual references, constituting the larger part of the literature, are so scattered and all but inaccessible as to be of little help to the inquirer.

When the orders were received which are noted in the letter at the beginning of this volume, two courses were open to the author. One was to attempt a rapid reconnaissance of the whole province, covering in a single season all the formations containing iron and all the localities from which it has been reported; but to do this would have led to the same superficiality as marked much of the early work upon this subject. The policy chosen has perhaps led to the opposite extreme; but it was thought that, by selecting for the first season's work a few localities and examining them in some detail, a greater service would be rendered to those interested in the iron ores of the country. Unlike many other places, Nova Scotia has never had the benefit of a single attempt to treat any of her geological features after the manner of a monographic study, however limited. There has been an undue optimism on the part of some, and an undue pessimism on the part of others, as to its iron. It is a country which has not limitless metallic resources, but it has some which are well worth greater exploitation, and its people will not be satisfied until they have before them authentic and detailed accounts of what they do and do not possess. Thus will they know how far they can go in each direction in the development of their land, and upon what lines the emphasis should be laid.

It was, therefore, planned to select for the first season's work localities which should be typical of the various methods of occurrence of the ores, and either of present or prospective economic importance. In making this selection not all the promising districts could be visited, so that there remains for a second season a fair number of those which lay some claim to being valuable, together with others about which too little is known to warrant such assumption. In accordance with the spirit of the instructions many problems of scientific interest, notably those of genesis of the ores and of structural and chemical history, have been left untouched.

It was at first intended to include a general study of the limestones in this volume; but difficulty in securing information in the time required, and the large size to which the work had already grown, made postponement advisable.

The illustrations are from many sources, in part personal, in part government and private surveys. The various individuals and companies possessing data germane to the study have without exception been most kind in offering assistance, and much of whatever value this monograph may have would have been lost, were it not for the information and documents placed by them at the disposal of the party. Some little exploration and development was conducted by a few of the interested parties, under personal direction, with benefit alike to the owner and the investigator. It is much to be regretted that, except in one instance and then only for a brief time, it was impossible to have access to any of the drills belonging to the Nova Scotia Mines Department. Their use would have cleared up several important points which as it is remain dark.

The survey party consisted, besides the author, of Messrs. F. H. McLearn, F. A. Grant, and J. B. Morrow, fourth-year students at the School of Mining and Metallurgy, Dalhousie University. No camping or packing was necessary, thus decreasing the size of the squad. Day labor was freely used whenever advisable.

SUMMARY OF THE CONTENTS OF THIS REPORT.

Part I.

Chapter 1 details the several geographic relations of the iron deposits of Nova Scotia. The ores are very widely distributed, only the great gold-bearing series occupying the southern part of the mainland being entirely exempt. A few important ore bodies are known, some which may upon future exploration be found to be important, and many that can never be of other than academic interest. The largest deposits now recognised are within easy reach of transportation, and are not too remote from fuel and limestone to make smelting possible under favorable conditions. The somewhat isolated situation of the province makes possible the production of iron and steel, when a keener competition and the proximity of powerful rivals would prevent profits from accruing.

Chapter 2 deals with the iron ore minerals in general. Magnetite is not promising in amount, except as a metamorphic product from hematite. The hematite in specular form, while often of high purity, has not yet been found in other than small and discontinuous bodies. The variety which has the greatest continuity is the massive Clinton type, typically developed at Torbrook. Limonite occurs under many conditions, notably, however, as contact deposits near the edge of the lower Carboniferous, and as an alteration product from carbonates in a very extensive series of fissures along the southern side of the Cobequid mountain range. Siderite exhibits some development in Pictou county, and in the Londonderry field in association with ankerite, but by itself has little importance. Ankerite in the Londonderry district is the immediate source of the hard and soft limonite, and by the gradual exhaustion of these is assuming an increasing value, being at once a flux and an ore. Its use causes unavoidable irregularity in the furnace, however, and its value is slight unless accompanied by a sufficient proportion of good ore.

Chemically the Clinton ores are low grade, high in phosphorus and silica, and variable but usually low in sulphur. The Londonderry limonites are especially low in both sulphur and phosphorus, and were exceptionally pure ores in the superficial workings before the zone of carbonates assumed the importance which it has to-day.

Chapter 3 discusses in a very general way the geology of the deposits. Special emphasis is laid upon the limiting conditions of iron deposition, as applicable in this province. It is held that, while iron indications are very widespread, a commercial degree of concentration will be found only when certain distinctly favorable factors have worked in harmony. In addition to abundance of solution, which is most likely to be present, there must be some limiting structure which will insure concentrated deposition within certain narrow bounds. Such are strata favorable for replacement, and some secondary structures. A note is made of the characteristic indications of iron in continuous body, and of certain methods of exploration and development too little followed in the country. Finally, the reis added a brief statement of the formations in which the iron ores occur.

Chapter 4 takes up certain matters relating to mining policy in the province. The cost of labour is noted, low relatively to western wages but high in comparison with wages which until recently were paid in Newfoundland. With regard to policies of capitalization and operation, it is pointed out that few deposits at present give promise of such size as will warrant large scale operations, and the wisest policy in most fields is small individual ownership and a tonnage contract with any smelter that will take the ore. It is held that there may, under slightly changed conditions, be opportunity for the successful operation of one or more smelters in the western part of the province, and possibly one in Pictou county.

Chapter 5 discusses the system of bounties paid upon iron and steel. It is held that, whatever may be thought of bounty systems upon principle, the present method has failed to stimulate the mining of iron ore in the province; and a method is proposed—not of necessity supplanting the existing plan—by which a bounty will go to the miner of the ore, thereby giving him direct encouragement.

Chapter 6 gives some information as to the steps necessary in securing and maintaining titles to iron ore properties in the province.

PART II.

Chapter 1: *Clementsport district.*—The ores of this basin are magnetites which have been metamorphosed from Clinton red hematites. Their extent is unknown, but three occurrences have been worked to a small degree in early years. Iron was made at the mouth of Moose river early in the last century, and appears to have been of good quality. The openings at present are those known as the Potter, Milner and Milbury pits. At least two of the beds cut should be continuous for a long distance, and should yield a large amount of ore. The grade is not well known, and must be established by drillings or fresh pits. Water power can be taken from Moose or Bear rivers. The district is regarded as a promising field for proper exploration, especially with a view to making it tributary to Londonderry, or to a new smelter at Parrsboro, Annapolis, or Victoria Beach.

Chapter 2: *Nictaux-Torbrook basin.*—This is at present the most important and promising field in the province. Its ores are Clinton hematite and bedded magnetite metamorphosed from it, all replacements of Silurian limestones and siliceous slates. In a general way they occur in two zones striking north-east. The northern zone contains two deposits of economic value—the Leckie and the Shell, the latter highly fossiliferous. These are the only two which have been operated, although openings have been made on several others. On the south are two continuous beds which have been thought by some to be equivalents of those mentioned on the north. Evidence to support this is lacking. The northern zone dips south-east at angles varying from 50° to 80°; the southern dips north-west at 80° or above. From the evidence now obtainable the general structure is tentatively regarded as that of an abnormal synclinorium, with an anticlinal centre pitching south-west and composed of smaller folds. In the east the dominant rocks are red slates and quartzites, as a whole underlying the ore-bearing formation. At the west the rocks are all gray, slates and quartzites predominating. Many isolated iron openings are to be found here, and it is impossible at present to tell the exact number or relationship of beds. The centre of the district is occupied by the two iron zones and their associated gray rocks on the sides of the basin. Black or Torbrook river gives a partial section of the centre of the basin in its western half, all in gray rocks. It is therefore inferred that the underlying barren red rocks plunge below the surface somewhere in the eastern half of the district.

At the western end of the field sundry surface openings were made many years ago, and some smelting done at Nictaux and Clementsport. The only mine until recently, however, has been the Leckie, at the eastern end of the productive area, and now closed. Thence westward the Leckie bed is known for 15,000 feet, and near the end of this a new mine, the Martin, is being opened. A third mine, begun a few years ago, is the Wheelock, located on the Shell bed. This deposit is known for 13,000 feet. In depth the Leckie was worked somewhat more than 330 feet, being lost by a pinching-in of the foot-wall. The Shell bed is known by drilling for 382 feet. It is probable that both are productive to a much greater depth, as the distribution of the bedded ores has little or no relation to present topography in this district. In some shallow workings at the west, a shell ore does appear to become more calcareous and of lower grade within a short distance of the surface.

Both the Shell and the overlying Leckie deposits are characterized by a rolling or shoot-like structure, the iron pinching to six feet or less, and in places to nothing, and in the rolls opening out to fifteen or eighteen feet. The dip of both walls is variable at the rolls. These structures pitch west at a low angle in the Leckie mine, and east in the Wheelock. Details of occurrence and method of working are given for both mines.

The chemistry of the ores in all parts of the field is given in as great detail as possible, from a large series of commercial analyses and those made in the laboratory of the Mines Branch. Of the properties recently in operation, averages are given below. The Martin opening was shallow at date of writing. The P and S of the second analysis are from the whole vein.

	Leckie (Leckie Vein)	Wheelock (Shell Vein)	Martin (Leckie Vein)
Fe.	49.200	43.693	53.670
Insol.	15.600	17.460	14.840
P.	.922	.750	1.054
S.	.077	.098	.074

The district is regarded as one of considerable importance. Water power sufficient for working purposes can be obtained from Nictaux river by storage. Transportation by rail is accessible in one direction at the mines, and could readily be brought within reach by a second line from Nictaux if required. The ore at present goes by rail to Londonderry for mixing with local limonite and carbonates; but water shipments could be made from Margaretville, Annapolis, or Victoria beach with a short rail haul, and Annapolis itself is well located for a smelting center.

Chapter 3: *Iron of the Triassic trap.*—Volcanic traps of this age extend continuously from Cape Blomidon to Brier island, along the south shore of the Bay of Fundy, and in numerous small patches north of the bay. Magnetite and hematite occur in these in many small bodies, often highly pure, but nowhere in economic quantity so far as known.

Chapter 4: *Devonian deposits of Hants and Colchester counties.*—In Hants county occur many small deposits of limonite, at or near the contact of Devonian and lower Carboniferous rocks, and lying generally in the former. The western occurrences are highly manganiferous. All are local pockets and at best capable only of contributing to some smelter. In some the ore has thus far proved to be too impure to use; but one especially, at Selma, is promising.

At Brookfield, in Colchester county, a pocket of hard limonite was worked for some years, giving 44,400 tons of which record can be had, and an unknown amount in addition. This averaged as follows:—

Fe	47.072
SiO_2	18.988
P	.100

A small amount of this pocket remains. The deposit is a nearly vertical lens in Devonian slates, near a contact with lower Carboniferous limestone. Recently a replacement of slate and limestone has been worked, which bids fair to have a large capacity. The average of clean ore from this for 1906 was:—

Fe	43.59
SiO_2	16.59

Drift ore in great abundance is scattered over a large territory, and recent exploration, while insufficient to uncover the deposits properly, yet shows that the district is one of considerable promise. The country is open, and a graded roadbed runs to the mine, hence rail transportation should be easy.

Chapter 5: *Ores of the western Cobequids.*—Iron ores occur along the south side of the Cobequid range of hills from Advocate on the west, eastward through Cumberland and Colchester counties and into Pictou county. The present study embraced a length of about 75 miles, stopping at the Debert river on the east. While there are many isolated localities in the Devonian at which the ore is exposed, most of them lie along a zone on the mountain side, stretching for many miles east and west. This narrow area is the seat of fissuring and shearing, accompanying the uplift of the range; and in the fissures are veins of iron minerals.

The original varieties are siderite (or strictly a magnesian variety called sideroplesite) and large amounts of ankerite—a carbonate of lime, iron and magnesia. The oxides which form the productive ore are relatively superficial, rarely being found far below present drainage, hence the workable part of the deposits is limited closely downward. However, their great length gives a relatively large capacity.

Acadia Mines, the center of the mining and smelting, has been active intermittently for many years. Steel is not made, but excellent pig has long been characteristic of this place. The ore is very low in P and S. An average of early workings here is as follows:—

	Specular Ore	Red Hematite	Hard Limonite	Paint Limonite	Ankerite	Siderite
Fe	67.440	50.040	57.450	45.470	9.830	35.060
SiO_2	.400	14.953	3.720	16.400	.260	3.180
P	.001	.819	.083	.136	.049	.068
CaO	....	....	....	....	29.168	....
MgO	....	....	....	....	11.911	....

For the year 1906, ankerite and siderite being included under the head general carbonite, the average was :—

	Fe	Insol.
General limonite	40.72	20.20
General carbonite	16.63	4.21

Details of the underground workings are given, as far as they could be gathered. A special point is made of the distribution of the ore-bearing zone, which is much more extensive than the worked portion of it, and it is shown that exploration is advisable away from the present mines.

Chapter 6: *Partially bedded ores of Arisaig and Malignant cove.*—The ores of the shore district of Antigonish county are in large part Clinton hematite. Some blebby deposits in trap have been exploited, but are not promising.

The bedded ores run roughly parallel with the shore, chiefly in Ordovician slates. Those in the eastern part, from Malignant cove to a point somewhere between East Branch Doctor brook and Iron brook, are too siliceous and too much under the influence of eruptives to promise much, and it has been impossible to correlate the various openings with any satisfaction, so that it is not known how many beds are present.

From Iron brook west, three deposits are recognized—the Coarse, Intermediate and Kidney or Tunnel leads. The first or southern one is worthless for smelting purposes, being everywhere very siliceous. The last was worked in a small way for the furnace at Ferrona, and when free from slate is of good quality. It is irregular in value, however, through the presence of stone lenses. The Intermediate bed is the most promising, and may prove of large capacity and satisfactory value. All three are known at present for a length of 6,700 feet. The depth to which the ore goes is undetermined, but does not appear to be related to existing topography.

Transportation would be easy, if the deposits were to justify extending the railway twenty miles. Water power may be possible by damming the lower portion of Doctor brook. On the whole the western end of the district promises to repay careful exploration. The average of such tests as have been available for the eastern part of the field, as far west as McInnes brook, and for the western part, follow. The average for silica is far too low, owing to the fact that silica was obtained only from samples taken chiefly from the old Tunnel lead workings, which were high in iron. The average for all would be in excess of 30.00.

Fe	36.960
SiO_2	19.200
P	.763
S	.010

Previous analyses, including those from McInnes brook, give :—

Fe	42.514
SiO_2	28.655

The western part of the field, including McInnes brook, gives (Mines Branch analyses) :—

Fe	41.090
SiO_2	16.340 (only four samples).
P	.758
S	.018

Analyses which may fairly be credited to the Intermediate bed average:—

Fe	47.45
SiO_2	14.85

The Kidney or Tunnel lead should average, when free from stone, 47.00 Fe.

Chapter 7: *Iron ores of Whycocomagh, etc.*—Claim has been made of the presence of large amounts of specular hematite and magnetite north and east of Whycocomagh, but could not be verified. To the west, at the eastern end of Skye mountain, a number of openings in pre-Cambrian slates and quartzites show irregular deposits of some size and a few which appear stratified. Some of these may prove to be capable of yielding enough good ore for the Sydney smelters to pay for working, but cannot be of great size. The quality is good, the Tunnel openings giving (average of five Mines Branch analyses) :—

Fe	54.230
SiO_2	14.364
P	.547
S	.036

Shipment to Sydney can be made by water during half the year, with little haulage.

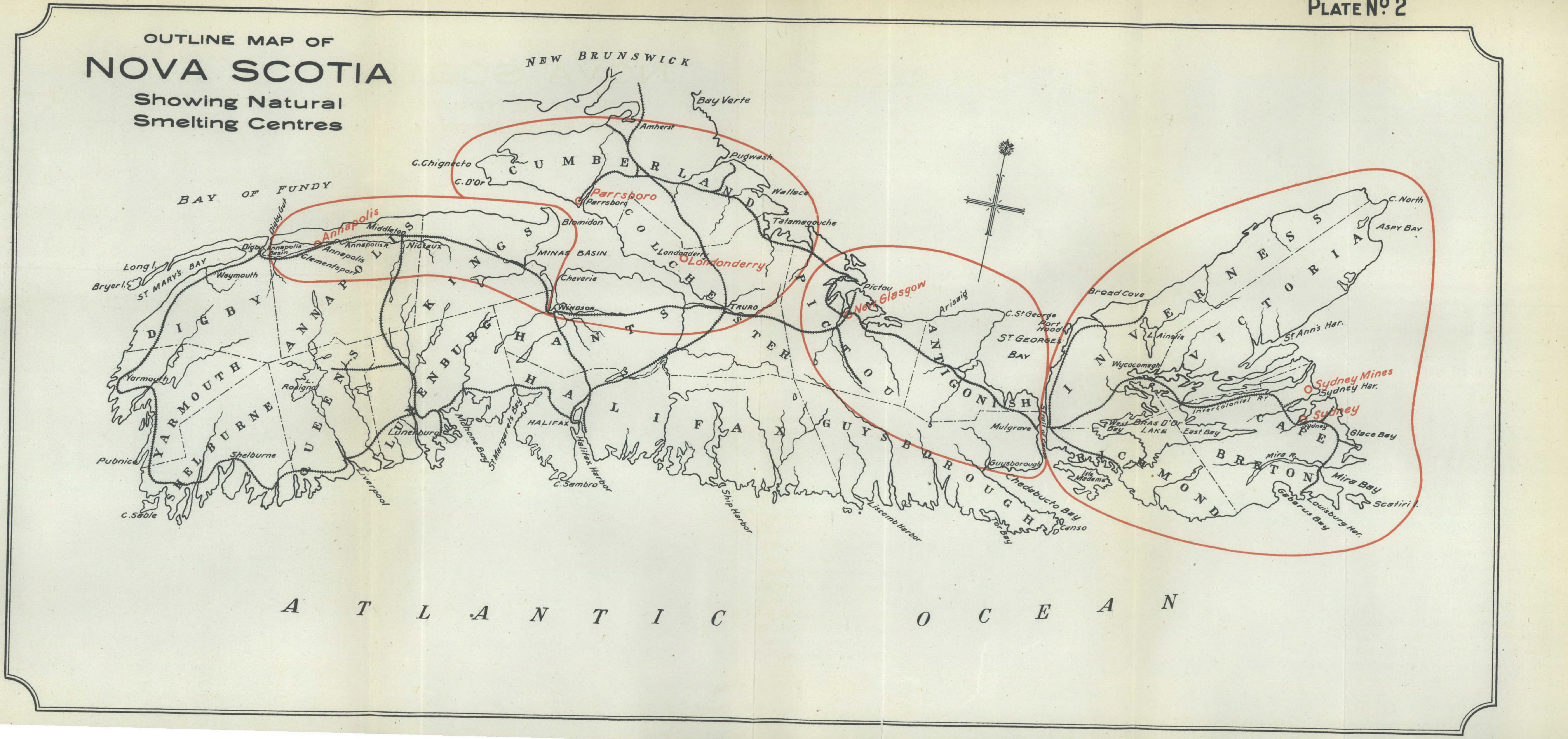
Chapter 8: *Iron ores of Barachois.*—These are situated near Little Bras d'Or lake and but a few miles from the Sydney smelters. On comparatively low land by the water side are irregular bodies of specular hematite and siderite, largely replacement masses. The chief deposit of the former is apparently discontinuous but of good grade. The spathic ore, which holds a small amount of specular, is lean for the most part.

At an altitude of 700 feet and a distance of a mile from the shore, magnetite occurs in a series of irregular bodies in pre-Cambrian dolomitic limestone, part of the protaxis of the Boisdale hills. The form and extent are unknown, but give promise of enough tonnage to pay for mining for Sydney. The ore is likely to be high in sulphur.

The quality of the specular and magnetic ore may be judged from the following averages:—

	Hematite	Magnetite
Fe	43.812	52.070
Insol	15.806	8.850
P	.100	.030
S.	.066	1.186

PLATE No. 2



OUTLINE MAP OF
NOVA SCOTIA
Showing Natural
Smelting Centres
NEW BRUNSWICK
BAY OF FUNDY
ATLANTIC OCEAN
Bay Verte
Amherst
Pugwash
Wallace
Tatamagouche
C. Chignecto
C. D'Or
CUMBERLAND
Parrsboro
Parrsboro
Blomidon
MINAS BASIN
COLCHESTER
Londonderry
Londonderry
Cheverie
Windsor
Truro
HANTS
Annapolis
Middleton
Annapolis R.
Nictaux
Digby Gut
Digby
Annapolis Basin
Annapolis
Clementsport
KINGS
ANNAPOLIS
Long I.
Bryer I.
St. Mary's Bay
Weymouth
DIGBY
Yarmouth
YARMOUTH
SHELBURNE
QUEENS
L. Rosignol
LUNENBURG
Lunenburg
Mahone Bay
St. Margaret's Bay
HALIFAX
Halifax
Halifax Harbor
C. Sambro
Ship Harbor
Liscomb Harbor
Pubnico
Shelburne
C. Sable
Liverpool
Pictou
New Glasgow
Arisaig
PICTOU
ANTIGONISH
C. St. George
Port Hood
St. George's Bay
GUYSBOROUGH
Mulgrave
Guysborough
Strait of Canso
Chedabucto Bay
Canso
Broad Cove
L. Ainslie
Wycocomagh
INVERNESS
VICTORIA
St. Ann's Har.
C. North
Aspy Bay
Sydney Mines
Sydney Har.
Sydney
Sydney
Intercolonial Ry.
West Bay
Bras D'Or Lake
East Bay
Glace Bay
Mira R.
Mira Bay
Scatiri I.
Gabarus Bay
Louisburg Har.
Isle Madame
RICHMOND
CAPE BRETON

PART I.—GENERAL CONSIDERATIONS.

CHAPTER 1.

GEOGRAPHIC RELATIONS OF IRON ORE DEPOSITS.

CONTENTS OF CHAPTER 1.

A glance at a general map of North America will show the position which Nova Scotia holds with reference to the rest of the world. With a long coast line and several remarkable natural shipping centres, with no part of the country remote from rail communication or inaccessible through topography, the province is especially well situated with reference to two lines of endeavor—providing the best gateway into Canada from Europe for imports or exports, and acting as a manufacturing centre for the west.

To apply this to the case in hand, Nova Scotia is well adapted for importing ores, if necessary, to be mixed with native varieties for manufacturing any of the numerous forms of finished iron and steel products, and for delivering these to the more western portions of Canada by rail, or exporting them by water to any desired points. From the standpoint of manufacture and transportation, what the seaboard Atlantic commonwealths are to the United States, Nova Scotia is to Canada.

General distribution of ore.—Looking at the map of that province, (Plate 1), it will be seen that iron ore is very widely distributed. Geographically, almost every part of the country, except the southern, is represented. It is the aim of this introductory chapter to indicate the relations of the ore-bearing localities to each other, and to the distribution of the remaining two essentials for iron manufacture—coal and limestone.

Commencing at the west, detached small deposits are found along the south side of the Bay of Fundy, all the way from Brier island to Cape Blomidon, and on the south shore of Cobequid bay towards Truro. Behind or south of the former line of deposits are the more persistent and important ores of the Clementsport and Nictaux-Torbrook fields. On the north side of the Bay of Fundy are many small and isolated occurrences near the shore, and a persistent and probably connected line of ore bodies from the western part of the Cobequid mountains east for many miles into Pictou county, and lying for the most part upon the south flank of the hills.

Detached deposits occur eastward through Pictou county, and through Guysborough county north of the country occupied by the granites and the gold-bearing rocks. In Antigonish county is a large field on the coast, that of Arisaig, and farther south small and numerous occurrences are noted, similar to the ones mentioned for Pictou and Guysborough counties.

In Cape Breton the iron ores are to be found in widely separated localities, and some few of the deposits promise to be of commercial importance. Many of these occurrences are close to the tide water of the Bras d'Or lakes, or within reach of transportation by stream or on the railway.

Thus the iron ore of the province is widely distributed; and is, in practically all localities now known, in close proximity to transportation, or can be brought into easy connection with it, should conditions warrant the expense.

Relation to fuel.—The coal fields of the province are numerous, and so widely distributed as to supply fuel at a number of smelting centres, should it be required. The plants of the Nova Scotia Steel and Coal Company and the Dominion Iron and Steel Company are fed from Sydney Mines and the Glace Bay district. On the west coast of Cape Breton are the Chimney Corner, Inverness, Mabou, Port Hood and Richmond fields, the first and last in initial stages of development. In the centre of the province is the Pictou field.

In the northern part of the country is the Cumberland county field, represented at present by the line of small collieries stretching from Joggins mines, on the shore of Chignecto bay, eastwards, and by the Springhill district. This field has great potential importance, in view of the fact that the horizons which contain the Springhill coal underlie the great stretch of 400 square miles of country westward to and under Chignecto bay. Thus there is at least a possibility of coal in great amount being present at a workable depth in that field.

The Londonderry Iron and Mining Company obtain their fuel chiefly from Springhill and the Pictou field at present.

Relation to fluxes.—The fluxes fall into two groups—limestone on the one hand, and dolomite and ankerite on the other. The first is low in magnesia, the second high, and the third not only high in magnesia, but containing a certain amount of iron.

The limestones are found in the pre-Cambrian (George river series) and Cambrian of Cape Breton, and in the Ordovician, Silurian, Devonian and lower Carboniferous limestone (Windsor series) throughout the province. The dolomites are found in the pre-Cambrian (George river series) of Cape Breton. The ankerite, which is practically an iron-bearing dolomite, occurs in abundance in the Londonderry district, and in variable quantity throughout the Devonian area south and east of the Cobequid mountains, in Colchester and Pictou counties.

In the west no limestones are to be found until the vicinity of Windsor is reached. Thence eastward up the Kennetcook valley, and intermittently to the strait of Canso, they occur in several formations. Some little of this is near present transportation. In Cape Breton limestone abounds within reach of shipping.

Out of all the occurrences of limestones and dolomites only a small proportion would be found fit for use, because especially of irregularity in composition. But even so, a sufficient amount of flux can be had for the use of any smelters likely to be erected.

Possible smelting centres.—It will be shown in the sequel that there are many small deposits of iron ore in Nova Scotia, and a very few of considerable size. That being the case, if the question arises of additional centres for the manufacture of iron and steel, it will be possible to point to but very few localities possessing the requisite qualifications. These are an adequate supply of suitable iron ore, flux and fuel, with cheap transportation for all these raw materials to the furnace, and proper shipping facilities for both incoming and outgoing freight. Since the cost of labor is even throughout the province, it does not enter as a factor in determining position.

From this standpoint the following may be taken as indicating a natural grouping, based upon proximity of location, ease of transportation, and relation to fuel and flux (See Plate 2):—(1) a western section in Digby and Annapolis counties, with its industrial centre at Annapolis; (2) a west central section, draining Kings, Colchester and Cumberland counties, and having Londonderry as a centre; (3) an east central section, embracing Pictou, Antigonish and Guysborough counties, with a focus somewhere in or near the Pictou coal field; (4) an eastern division, including all of Cape Breton, with its centres at Sydney and Sydney Mines.

Reference to the accompanying map will serve to indicate more clearly the limits of each district.

Relation to ore and metal markets.—The province of Nova Scotia shows no probability of developing an iron industry from its own ores that will enable it to compete very extensively with the American and Ontario products in their own fields. Its success must result from its comparative isolation, which diminishes the intensity of competition. It has, so far as now known, no deposits showing such size, quality and low cost of treatment as to compare favorably with Bell island on the one hand, or the Lake Superior ores, both Canadian and American, on the other.

But there does appear to be a possibility that Nova Scotia may yet be able, with her own ores, to supply eastern Canadian demands; and products manufactured from Newfoundland ore already find a market whose extent is increasing each year. Every ton of iron or steel that can be made from native ores at a cost to meet the existing conditions of trade can be sold. Whether or not iron and steel can be made from native ores for export, there certainly will be room in the near future for all the metal that can be produced for manufacturing purposes in eastern Canada, and especially in the provinces of Nova Scotia and New Brunswick.

CHAPTER 2.

THE IRON MINERALS.

Contents of Chapter 2.

Sources of Metallic Iron.

It may be worth while, in view of the mineralogical references and descriptions in this report, to set forth briefly the characteristics of the various minerals which go to make up the iron ores of Nova Scotia, and the accessory impurities which affect their value.

PLATE 3.

(*a*) Hematite: Wabana, Newfoundland.

(*b*) Shell magnetite: Torbrook.

The former may be enumerated as magnetite, hematite, limonite (the brown hematite of the trade), ankerite and siderite. Certain varieties which are less common or are but slight variations of other species are turgite, goethite and sideroplesite.

Magnetite.—Composition Fe_3O_4, yielding when pure Fe 72.4%. This gives the highest ratio of metallic iron possible in an ore, a fact worth remembering when approached by some optimistic owner or agent with tales of ore 80% iron. It has never been known to occur pure in masses of more than a few tons, or of very high grade in deposits yielding more than a few thousand tons. Indeed, the largest single rich run was 40,000 tons from Barton Hill, near Mineville, New York, with a total average of 68.6 Fe, and with much of the deposit above 72.

The Swedish magnetites run over 65%, an average of three lots to the Nova Scotia Steel and Coal Company being 68.823; Mineville, New York, 63; and other deposits worked in the United States down to 42.70, with an average of say 56.27 for a large number. Few of these are metamorphosed hematites, while several of the magnetic ores of Nova Scotia are of this character. We have here, moreover, none of the gabbroidal magnetites which furnish the titaniferous ore in other parts of the world, and which are excluded from the average given above.

The Triassic trap magnetites of this province vary much, from 68.33 to 35.25, an average of ten samples being 55.13. They often contain some specular hematite. The altered hematites of the Nictaux-Torbrook and Clementsport basins, while highly magnetic, usually have a brownish or reddish streak. They should be classed for the most part with the Clinton red hematites; but such as have been sufficiently metamorphosed, like those of South mountain, are true magnetites. A fair average of these, based upon twenty samples, is 44.02. The shell magnetite of the Heatley property, from nine samples, averages 35.26; that from the Ward estate, east of Nictaux river, of seventeen samples, averages 40.95. An average of all the western occurrences gives 42.32. The pre-Cambrian magnetites of Cape Breton vary widely. Those of the McPherson areas, Barachois, appear to run approximately 52.07.

The magnetite of this country rarely, so far as known, occurs as a loadstone. In all other respects, it is typical in various cases.

In the Triassic trap it is at times extremely well crystallized in gas and gash cavities, and in most of the deposits it is coarsely granular to massive. In some places the mineral martite occurs but has only a scientific interest. In the pre-Cambrian limestones of the George river series, in Cape Breton, it is in places disseminated in grains in the dolomites (Whycocomagh), and in others massive to granular (Barachois).

In the Nictaux-Torbrook basin it is an alteration product of hematite, probably by contact metamorphism, and here it preserves the appearance of the latter as far as conditions permit.

Hematite.—Composition, Fe_2O_3, yielding when pure 70% Fe. Taking all the factors into consideration, it is by far the most important species economically. This is due to the great size of its body in some cases, and to the large tonnage of high grade ore.

Its varieties are several—ochreous, specular, and massive oölitic being some of them. The first named is the richest ore, millions of tons of Lake Superior ore running 65% or even more.

The famous Spanish ore from Bilbao gives 49%; the Almeria from Alquife, 48.85 dry. In the Lake Superior region, of the non-siliceous ores, Marquette in earlier years averaged 56.5, Menominee 55.24, Gogebic 56.308, Vermilion 61.36, and Mesabi 56.10. The siliceous ores found in three of these districts ran :—Marquette 42.27, Menominee 42.129, Vermilion 51.194, which are more like the values in our own non-specular hematites than are the first named figures.

In Nova Scotia no high grade specular deposits have yet been sufficiently explored to prove that they are of workable size; thus such analyses as can be given are for the most part sample assays from veins only, or are from districts outside the scope of this report. The chief exception is the Barachois specular ore, small lots of which run to 66.66. The specular ores of Londonderry are in a class by themselves, in that they have a highly micaceous structure, but for the most part a brown to brownish red streak, due to the percentage of moisture. To get average analyses is by no means easy, as at least in recent years the specular iron is so mixed with ankerite, limonite and siderite that no large lots of moderately pure ore come to the furnace. As close an average as could be made, extending over some years, gave 67.44.

The Clinton red ores in Nova Scotia are, next to the mixed ores of Londonderry, the most important. The typical Clinton ore in New York averages 44%. The Leckie ore at Torbrook averaged 49.20 for a number of years. The Shell ore at the Wheelock mine ran 42.74 as an average for 1906, and 44.05 for the first four months of 1907.

The somewhat similar ore at Arisaig varies much, largely owing to the percentage of silica. Some extensive beds are too low in iron and too high in silica to work at all, while others are fair, especially in the west. A general average of 54 samples of the eastern two-thirds of the district, by various analysts, gives 40.05 Fe. It may be that the district west of McInnes brook would bring this up slightly.

The partly specular, partly massive hematite of the upper ore body on the Greener areas at Barachois, Cape Breton, yielded an average of 45.34 from 513 tons shipment, and 47.33 from six samples.

Limonite.—Limonite proper has the formula $2Fe_2O_3, 3H_2O$, giving Fe 59.89%, moisture 14.4. In practice, however, it is found that the proportion of water varies greatly, especially in the direction of the species goethite (Fe_2O_3, H_2O). It takes a great variety of forms, colours, and degrees of hardness and compactness: botryoidal (bottle ore), stalactitic, semi-fibrous, massive or specular in form; many shades of yellow and brown to almost black in color; dull to very high in lustre, and hard to earthy (as in paint ore).

PLATE 4.

(*a*) Goethite: Bridgville, Pictou county.

(*b*) Fibrous limonite: Londonderry.

PLATE 5.

(*a*) Botryoidal limonite: Londonderry.

(*b*) Limonite in geode form: Londonderry.

The limonites of the United States, as worked, range from 40 to 50%. It is easy to find samples running much higher, up to 56 or more, but many also run below 40 because of impurities. An average of a large number of commercial tests from all parts of the country gave 47.91. The famous Alabama limonites run 50.89.

The important limonite deposits in Nova Scotia belong largely to two groups—the Londonderry series, and contact pockets. Part of the second group lies outside the scope of this volume.

At Londonderry and Brookfield, the two localities considered here, the iron contents vary within wide limits, depending not only upon the amount of impurity, but also upon the type of ore and degree of hydration. At Londonderry the assay has run as high as 59.40, probably due to a small percentage of specular ore. An average of very many furnace runs marked brown ore, taking into account as far as possible only the hard limonite, is 43.36. An average of twelve analyses made in earlier years, and probably including much bottle ore, is 57.45. Paint ore, from its high moisture content, is much lower than the bottle and specular ores, averaging 45.47 for ten analyses. A special disadvantage is the loss of energy in the furnace in driving off the water.

At Brookfield the highest analyses of the Chambers pocket at the Londonderry furnace gave 58.95, and an average was 46.62 from thirty-seven analyses. At the Ferrona furnace the average was said to be 47.523.

Siderite.—Composition $FeCO_3$, giving Fe 48.27%. This is in the main the white ore at Londonderry, and would not be considered were it not an important constituent of the iron-bearing veins. In the United States spathic ores are regarded as far too lean to work, frequently going down to 30% Fe.

At Londonderry siderite is mixed with ankerite, and to a less extent with various forms of limonite, so closely that comparatively few separate analyses exist. An average of such as could be secured is 35.06. The Londonderry siderite really belongs for the most part to the magnesian sub-species sideroplesite.

Ankerite.—Theoretical composition $CaCO_3$ (Mg, Fe) CO_3, yielding 50% $CaCO_3$, 21% Mg CO_3, 29% $FeCO_3$, and giving 14.00% Fe for this formula. The mineral is very variable, however, and is usually mixed mechanically with siderite, sideroplesite, specular ore and massive limonite.

Elsewhere than in the Cobequid mountain region of Nova Scotia this variety is so uncommon that in text books on mineralogy it is given only a very minor place, and nowhere else, so far as known to the author, is it of great importance in smelting iron. Hence a brief description of its appearance and its effect upon the furnace charge may not be out of place here.

When pure it resembles white siderite (or sideroplesite) so closely as to be easily mistaken for it. Indeed it is doubtful whether in some cases even an experienced eye can detect the difference. It crystallizes in rhombohedrons, and in the coarse specimens the surface of the rock is made of numbers of intersecting rhombohedral faces. Ordinarily it is coarser than siderite in the same part of the mine, but it is easy to find hand specimens of the two species with identical texture. Weathered faces show cross-hatched lines and are brown in color.

Since ankerite contains iron, lime, and magnesia, it is useful as a flux and at the same time contributes to the iron content of the furnace charge. It renders possible at Londonderry the use of limonite of lower iron value than would otherwise be serviceable; but it requires a larger proportion of ankerite than would be used if an ordinary limestone were employed, because of the low percentage of $CaCO_3$.

It is difficult to obtain analyses of ankerite sufficiently pure to be considered typical of the country. The iron appears to range from 7.37 to 11.31, and to average 9.83.

IMPURITIES.

Common accessories.—Chemical purity in any iron ore is not to be expected. Nevertheless, in the earlier days of Lake Superior mining specular hematite ran 69% Fe in the Republic mine for a whole season.

The common impurities are, of course, the substances entering into the gangue when present, and into the wall rock or into the rock which the iron mineral has imperfectly replaced. Silica (SiO_2), alumina (Al_2O_3), lime (CaO), magnesia (MgO), manganese (analysed as MnO_2,) titanic acid (TiO_2), carbonic acid (CO_2), water (H_2O), sulphur (usually in pyrite, FeS_2, but analysed as S) phosphoric acid (P_2O_5, analysed usually as P), and organic matter are the substances in question. All these influence the character and fluxing property of the ores, and in some cases, the character and composition of the pig. Certain of them, especially TiO_2, P_2O_5 and S, are especially deleterious. The others are harmful chiefly when in excess.

Certain of these will be considered in order below.

Silica.—The commonest impurities in iron ores are the oxides and silicates, most abundant in the superficial rocks of the earth, together with a few chemical elements in other forms. As silica constitutes 29.30% of the whole of the superficial part of the earth, it is not unnatural to find it the most common accessory of even so basic a substance as the iron oxides.

Silica may, in exceptional cases, be present as granules scattered through the iron ore (Coarse lead, Arisaig). In other deposits it is in fine or coarse stringers of gangue. Usually, however, while present chemically it is physically invisible as an individual unit. In excess, it hardens the ore, gives to a fresh fracture face a glistening appearance, and turns the streak or powder light colored.

It is characteristic of very many of the Nova Scotian ores to be highly siliceous. The magnetites of the Triassic trap vary widely, because of the different percentages of gangue. An average of the analyses now available gives 13.80. In the Nictaux-Torbrook mixed magnetites and hematites an average of a very large number (236) of analyses from many localities gives 17.55. Two properties have been worked to the extent of yielding a large tonnage, shipped from Torbrook to the Londonderry (Acadia Mines)

PLATE 6.

(*a*) Ankerite and specular ore: Londonderry.

(*b*) Ankerite core surrounded by limonite: Londonderry.

smelter—namely, the Leckie and Wheelock mines. The latter is new and still in process of development, the former is worked out. The Leckie mine, operating on a bed of massive Clinton ore with only an occasional fossil shell, averaged 14.808. The Wheelock mine, on a highly fossiliferous bed of magnetic hematite, has averaged 17.46 throughout 1906. In the early part of 1907 the ore was running 16.58 insoluble matter at the furnace.

Of the limonites between Windsor and Truro too little is known chemically to give fair average analyses.

In the Brookfield limonite pocket worked by Mr. R. E. Chambers, that part shipped to Acadia Mines averaged 23.02 SiO_2. The portion later smelted at Ferrona was said to average 12.00, but computation from a large number of analyses gives 14.955. Assuming that approximately one-half went to each smelter, which appears to be the case, the general average is 18.988. Why the first or Londonderry shipments were so much higher does not appear, for it was during the use of the Ferrona furnace that the pocket was skinned, the leaner ore from the wall being taken.

Of the more calcareous ore now being mined at Brookfield a fair average is 16.39 insoluble.

Turning next to the Londonderry ores we find great diversity, partly dependent upon the type of ore, partly upon the portion of the mines under operation at the time. Thus, 14 samples of red hematite from West Mines give 1.40% SiO_2. Another gives 4.00. Red hematite from the Rogers field, lying west of the Intercolonial railway, and between Acadia Mines and East Mines, ran 17.26, part being very pure, but toward the last degenerating so far as to give Fe 40.20, SiO_2 22.35. Limonite paint from East Mines gave 16.40; of semi-crystalline black ore, a hard botryoidal form, the only analysis in full gives 2.67. Specular ore averaged .40. A general average of brown ore for 1906 was 20.20; of ankerite and white ore (siderite) mixed, 4.31.

The Arisaig hematites are very highly siliceous as a whole. Thus the average of four samples from various pits on East Branch Doctor brook gave Dr.Hoffman 25.76% SiO_2; of eight samples on Iron brook, 26.33; of five samples at McInnes brook, 22.56. Analyses from samples taken by the present writer do not include the poorer ore, here as elsewhere; hence it is not possible to state the conditions west of McInnes brook with certainty. The analyses at hand average only 15.58; but judged by their appearance, with one exception the western ores are only slightly less siliceous than the eastern. The Whycocomagh hematite of Skye mountain, in the Tunnel mine, gives 12.364 SiO_2. The other openings are so scanty in their evidence as not to have much importance, as is also true of the specular ores of the north side of Whycocomagh and of Middle river.

The Barachois hematites, so far as shown by workings on the Greener-Ingraham areas, yielded on a 500 ton shipment 16.91 silica. Six analyses of various dates give 13.80, while present work is yielding 20.00. The magnetites of the pre-Cambrian from the McPherson property have given 8.85 in nine analyses, partly of car load lots. In some of the pre-Cambrian iron associated with impure dolomites and serpentinous limestones, there is a marked tendency for the ore to be extra siliceous, owing to the abundance of serpentine (hydrous silicate of magnesium) and various minerals of the amphibole group (especially tremolite and actinolite, lime-magnesium silicate and lime-magnesium-iron silicate).

It is unfortunate that, in almost all the analyses of hematite at present available, silica is not separated from the total insoluble matter.

Alumina.—This is rarely present in such quantities as to be deleterious, except where the ore is mixed with argillaceous country rock, the silica in that case increasing rapidly also. In most parts of the province it is unimportant. Triassic trap magnetites give a trace; Torbrook hematites and magnetites 4.214; Londonderry hard limonites .525, brown ore 3.76, specular ore .187, and siderite .67. Some of these, however, depend upon few analyses. For Brookfield limonite no data are available at present. This is to be regretted, as clay mixture always made trouble with the Chambers ore, and will do so with that now being mined. Eastern Arisaig hematites give 5.555, west of McInnes brook 6.748. The Whycocomagh ores of Skye mountain, while not tested sufficiently for accuracy, run 4.898 in the samples collected in the season of 1906. One previous analysis gives 2.42. The hematites of Barachois gave 1.90 at the big pit on the Greener-Ingraham areas, the magnetites of the Boisdale hills 3.22.

Lime and magnesia.—The magnesia in Nova Scotian ores is so relatively unimportant, except at Londonderry, as not to require detailed treatment. In the white ore and ankerite (both carbonates) of Londonderry it is very high, averaging 25.04 $MgCO_3$ in the latter and usually present in the former. Normal pure ankerite would give 21%. Obviously, therefore, less magnesium is replaced by iron in the ankerite than the formula calls for.

The lime is of interest in certain instances, notably in Torbrook and Londonderry. The former is a hematite replacement of calcareous beds (Shell vein); the latter limonite, and specular hematite or limonite, associated with carbonate ores.

At Torbrook two localities are important as indicating the greater completeness of the replacement near the land surface in some instances. Other deeper openings show the conditions not to be universal. But in the pits on the Ward estate, between the Bloomington road and Nictaux river, and in the Hoffman shaft, a distinct increase in lime and decrease in iron was met downward. In the former the change is steady, in the latter not.

At Londonderry the proportion of lime depends very largely upon the kind of ore. When the oxides decrease and the carbonates increase in depth, as appears to be the case universally but at various levels, there is a loss of iron and gain in lime. Typical specular ore gives .20 CaO; paint or ochre .46; ankerite 29.168, and siderite 2.89. Normal ankerite should have 28% of CaO, and pure siderite of course would have none.

Manganese.—Probably no other accessory constituent of the iron ores is so capriciously distributed as the manganese. All the varieties seem to have it in places, while a few ores are practically free from it. The Triassic magnetites and the Torbrook magnetites and hematites have very little, and that not persistently. One exception at Torbrook is the Foster ore, which has reached 21.27. The contact limonites and hematites of Hants and Colchester counties, on the other hand, have much in places. Thus at Goshen one sample, unusually high, ran 24.74%. Two subsequent tests gave only .55 and 1.11. As manganese mines lie for some miles to the east, it is not to be wondered at that this element should be present in some of the iron ore of the vicinity. The limonite pocket at Brookfield carried a small amount in places, in others considerable, and averaged 4.253. The ore now coming from there gives 2.75%.

The Londonderry ores are very erratic, but as a whole are not characterised by manganese, a general average being about .506. Some of them, however, run up to 9.80, although this is very rare. The Whycocomagh magnetic hematite of the Tunnel mine gave .329. At Barachois the hematites run .058, the magnetites .302.

Moisture and combined water.—For practical purposes these are important only in the limonites and associated ores in this province. The moisture varies in the same ore with different conditions of the ore ground, many large bodies having both hydrous and anhydrous iron. Thus, of the high grade ores of the Lake Superior region, mixed hematites and limonites, Marquette has 11.85% water, Menominee 6.525, Gogebic 10.828, Vermilion 4.365, and Mesabi 12.316. The siliceous lean ores run much less: 1.23% for Marquette, 2.20 for Menominee, and 3.21 for Vermilion. Normal limonite has 14.4% water. Unfortunately, in analysis often no distinction is made between hygroscopic and combined waters.

The Torbrook hematites have very little. The Brookfield limonite ran 10.223. At Londonderry moisture ranges widely, a fair average for the brown ores being 18.365.

Titanium.—Nova Scotian ores are not impaired to any serious extent by titanic oxide. The magnetites from the trap appear not to have it under ordinary circumstances, while the Torbrook magnetic hematites only occasionally show any. In fact, titanic oxide is a negligible quantity in Nova Scotia.

Phosphorus.—Unfortunately the iron ores of Nova Scotia are almost everywhere high in P_2O_5—phosphoric acid; and it is quite safe to say that, unless some high grade specular ore-body of magnitude is discovered, there are no uniformly Bessemer deposits of importance in the Province.

As many writings on the subject do not make the matter clear, reference may be made here to the Bessemer limit. The limit of phosphorus allowed in pig by the Bessemer process is .1%. American operators are becoming more exacting within the last few years, accepting no Lake Superior ore which gives over .05 P, no matter how high the iron. The error that is often made is in considering that the *ore* may run .1% P and still be a Bessemer ore. But since the metallic iron in an ore is always 72.4 or less, the amount of phosphorus allowable in the ore to make .1% P in the pig, will be .0724% or less, and is found by dividing the metallic iron content by 1,000. Thus a 45.50 ore will be a Bessemer ore only if it has .0455% P or less.

Of the Triassic trap iron, some is high in phosphorus and some low; but the bedded Clinton ores of the Silurian are uniformly high. The number of analyses for South mountain is small, but the average for that part of the Torbrook district appears to be 1.995. For the Cleveland mountain or west end of the district, and the Ward estate east of Nictaux river, the average is .769. In the Wheelock mine thus far the magnetic shell hematite has run 1.110. The average for the massive red hematite of the Leckie was .922. An average for the district as a whole would be 1.030.

The contact deposits of limonite are everywhere low, with a few individual exceptions. Thus Brookfield averaged .1044. The Londonderry ores, both brown and white, are practically free from it for the most part. On the other hand, individual analyses run as high as .460. The Whycocomagh Skye mountain ores run approximately .367, and the hematites of Barachois .100. The magnetites of that place give .030% P, and thus are Bessemer grade.

The Arisaig ores are uniformly high, an average of 36 analyses from the eastern two-thirds of the district giving .572 P. Mines Branch analyses give for the eastern part of the field .770, for the western .758.

Sulphur.—Of this deleterious substance there is little in most of the Nova Scotian deposits, while some ores run high locally. The Triassic trap iron is as a whole very free from it. The Clinton ores of the Torbrook region will run .109. The Brookfield limonite pocket was very free from it; but any ore nearer the Carboniferous contact may be more liable to it, because of the presence of barytes at the contact. Indeed, at one outcrop limonite has replaced barite, retaining the crystalline outline of the latter.

The Arisaig ores run from a trace to .005. The Skye mountain magnetic hematite of Whycocomagh varies, having much sulphur in places, especially near the front of the tunnel and on the east wall. The Mines Branch samples gave .033. The Barachois hematites yield .066. The magnetites will vary. Even at the trans-mountain road, where are the only workings, parts contain much, others little. The range up to the present is from .204 to 6.18 from the openings near the trans-mountain road. North-eastward the ore becomes more sulphurous, giving a wholly prohibitive amount at the end of the range a mile away.

Summary of Chemical Conditions.

Ores elsewhere than in Nova Scotia.—For comparison, analyses of certain foreign ores are given, and of the Michipicoten ore.

	Fe	SiO_2	Al_2O_3	CaO	MgO	P	S	Moisture & comb. water
Pure magnetite	72.400	......	......	......	......	......	......	......
Swedish magnetites	64.950	10.000	......	......	......	.013	......	......
Hibernia, N.J., magnetites	63.750	......	......	......	......	.364	......	......
Mineville, N.Y. magnetites	62.100	......	......	......	......	1.198	......	......
Aver. 11 American magnetites	55.865	9.944	3.456	......	......	.271	.179	......
Pure hematite	70.000	......	......	......	......	......	......	......
Marquette (hem. & lim.)	56.500	4.584	......	......	......	.035	.009	11.850
Marquette siliceous ore	42.270	35.834	......	......	......	.032	.010	1.230
Menominee (hem. & lim.)	55.242	6.769	......	......	......	.059	......	6.525
Menominee siliceous ore	42.129	34.141	......	......	......	.024	......	2.200
Vermilion (hem. & lim)	61.360	4.255	......	......	......	.037	......	4.565
Vermilion siliceous ore.	51.194	22.364	......	......	......	.050	......	3.210
Michipicoten (1900)	58.700	5.660	.730	.260	trace	.114	.047	......
Clinton, N.Y., fossil hematite	44.100	12.630	5.450	......	......	.650	.230	2.770
Wisconsin fossil hematite	51.750	......	......	......	......	1.392	......	......
Normal limonite	59.890	......	......	......	......	......	......	14.400
Alabama limonites	50.890	......	......	......	......	.225	......	......
Alabama limonites, average	48.540	11.220	3.610	.840	......	......	......	13.000
Colorado limonites	43.000	20.000	......	......	......	.030	......	13.000
Aver. 29 Penn. limonites (Ordovician)	43.470	18.970	2.390	.480	.420	.484	.060	11.620
Aver. 11 American limonites (various states)	47.881	12.271	2.449	......	......	.266	.204	13.270
Normal ankerite	13.978	......	......	28.000	9.996	......	......	......
Normal siderite	48.270	......	......	......	......	......	......	......

Ores of the Triassic.—Below is an average of analyses obtainable from iron of the Triassic trap in Nova Scotia. With it are a fair maximum and minimum for each ingredient.

	High	Low	Average
Fe	68.230	35.250	55.130
SiO_2	24.200	5.460	11.120
Insol.	35.800	8.830	17.610
CaO	1.200	.110	.655
MgO	4.840	.937	2.317
MnO_2	......	......	.080
P	.056	trace	.025
S	.046	.021	.034

Clementsport basin.—Few analyses are available for the Potter and Milner openings. Such as can be had, however, give the following averages:—

Fe	51.192
SiO_2	12.345
Insol.	28.187
P	.240
S	.159

Nictaux-Torbrook field.—Many tests may be had for this basin, and as a result several averages are given below.

	Leckie mine	No. anal.	Leckie vein	No. anal.
Fe	49.200	229	49.427	250
SiO_2	15.090	17	14.868	55
Insol.	15.600	21	....	....
Al_2O_3	4.424	9	4.168	15
CaO	4.940	6	4.235	11
MgO	.666	6	.534	9
MnO_2	.744	8	.591	11
P	.922	55	.952	75
S	.077	11	.071	17

	Wheelock mine	No. anal.	Shell vein	No. anal.	South mt.	No. anal.
Fe	43.693	current	44.132	81	44.020	36
SiO_2	....	furnace	16.605	81	20.776	23
Insol.	17.460	runs	....	.....	....	......
Al_2O_3	....	....	4.843	6	4.927	3
CaO	....	....	6.790	7	3.950	3
MgO	....	....	....	.....	.500	3
MnO_2	....	....	....	1	.282	5
P	1.110	....	.750	25	.995	18
S	....	....	.098	11	.088	11
TiO_2	....	....	....	.....	.061	3

	Ward, Heatley, etc.	No. anal.	Gen. average	No. anal.
Fe	42.320	36	48.767	476
SiO_2	24.420	28	17.552	236
Al_2O_3	2.792	5	4.214	39
CaO	6.663	10	4.941	41
MgO	.932	5	.443	27
MnO_2	.491	6	.506	39
P	.769	13	1.000	173
S	.177	13	.109	76

The contact ores between Windsor and Truro have so few analyses to their credit that averaging is not feasible.

Brookfield.—An average of the large pocket worked out by Mr. R. E. Chambers is given below. That of the ore now being extracted by Mr. J. K. Pearson will be treated in a subsequent volume.

Fe	47.072
SiO_2	18.988
CaO	7.495
MgO	.250
MnO_2	4.253
P	.100
Moisture	10.223

Londonderry.—In this district it will be necessary to keep separate account of the different classes of ore. Earlier analyses give higher iron ratios than more recent ones, as may be seen by turning to the current analyses in Part II. Whether this is due to difference in the ore or to stricter accuracy in analysis at present, or to both, is an open question. Of red hematite (chiefly Rogers ore) there has been an exceedingly small amount.

	Specular ore	Red hematite	Limonite hard	Limonite paint	Ankerite	Siderite
Fe	67.440	50.040	57.450	45.470	9.830	35.060
SiO_2	.400	....	3.720	16.400	.260	3.180
Insol	2.340	14.953	....	....	....	....
Al_2O_3	.187	7.210	.525	2.210	no records	.670
CaO	.200	1.270	.371	.460	29.168	2.889
MgO	.095	.673	.219	.420	11.911	5.535
MnO_2	.050	.896	.934	1.936	1.109	2.266
P	.001	.819	.083	.136	.049	.068
S	.194	.353	.013	.055	....	....
Moisture	2.010	....	11.557	10.952	....	....

Arisaig.—Since this district is chiefly distinguished with reference to control of its iron ores by being divided into two properties, averages are given here first for the ores as a whole as far west as the west side of McInnes brook (only analyses of the best ore being available for SiO_2), and second for the exposures west of that point.

	McInnes brook and east (M. Branch sam.)	West of McInnes brook (Mines Br. samples)	General aver. (previous analyses)	Gen. aver. (Mines Br. samples)
Fe	37.188	44.680	42.514	38.070
SiO_2	19.260	15.580	28.655	18.950
Al_2O_3	5.555	6.748	6.643	6.032
CaO	2.310	2.638	....	2.440
MgO	.347	.700	....	.488
P	.770	.758	.572	.765
S	.010	.021	.051	.014

Whycocomagh.—The occurrences on the north side are not worth averaging. Those on the west (Skye mountain) give the following:—

	Previous anal.	Mines Branch samples
Fe.	48.825	51.667
SiO_2.	21.550	16.020
Al_2O_3	3.798	4.850
CaO.	2.624	1.783
MgO.		1.563
MnO_2.	.329	....
P.	.358	.377
S.	.223	.033

Barachois.—The hematites and the magnetites are here given separately:—

	Hematites	Magnetites
Fe.	43.812	52.070
Insol.	15.806	8.850
Al_2O_3	1.900	3.220
CaO.	8.728	1.024
MgO.	no data	5.152
MnO_2.	.058	.302
P	.100	.030
S.	.066	1.186

From this can be gathered a general idea of the chemistry of the iron ores in the districts studied. Detailed discussion is further taken up in Part II. In some instances, especially Torbrook and Londonderry, the averages given in this chapter are made without reference to the analysis of samples collected during 1906 by the Mines Branch field party.

CHAPTER 3.

GENERAL GEOLOGY OF IRON DEPOSITS

CONTENTS OF CHAPTER 3.

FACTORS INFLUENCING IRON ORE DISTRIBUTION.

Purpose of chapter.—While the aim of the work upon which this report is based has been to keep entirely in the background all geological matters which have not a direct bearing upon the economics of the subject, it has been thought best to insert a brief statement regarding the general geology of iron ores, especially such as occur in the province of Nova Scotia, and with particular reference to the questions of permanence and continuity.

There is a special reason for regarding this as important; namely, that many owners of land and of mineral rights in the province appear to believe that iron minerals are iron ore, and that the presence of these minerals, no matter in what form or amount, is indicative of a profitable ore body. This has led on the one hand to highly exaggerated ideas regarding the iron wealth of the country on the part of a large number; and on the other hand to an undue pessimism, which is almost as unhealthy. The chapter makes no pretense of being a general dissertation on iron ores; it merely gives certain facts bearing especially upon the problems presented by Nova Scotian deposits.

The point which the author seeks to emphasize is that, to produce large and profitable bodies of iron ore, there must have been agencies at work tending to localize the iron-bearing solutions, or persistent situations, whether structures or strata, which are easily seized upon as deposition centres by such parts of the solutions as meet them. Widespread iron indications are, on the whole, unfavorable rather than favorable, in very many instances.

Comparative shallowness of iron ores.—The first fact requiring emphasis is that, with few exceptions, iron ore occurs as comparatively shallow deposits formed by deposition from downward moving surface waters. The exceptions are such magnetites as are chemical segregations.

The limonites are usually formed above the level of ground-water for the district, in the zone in which the waters exert a strong oxydizing and hydrating influence. Or if the deposits are below ground-water level at present, it is because of topographic changes since deposition of the mineral. This has a bearing upon several of the Nova Scotian deposits, particularly the Londonderry iron-ankerite zone.

The hematites, specular, and soft and hard red, are also shallow compared with the ores of many other metals, while going far below ground-water level. They are limited in depth by the distance to which the downward moving water will go and still retain its power of deposition of the iron oxides; or, in other words, iron oxides will not be deposited at a depth where the water has suffered a marked increase of solvency over its surface condition. This is equally true of the magnetites, except those that are chemically basic segregations from molten rock.

Limiting conditions of deposition.—Bearing this in mind, it is in order to inquire what are the limiting conditions which cause deposition of the iron oxides from solution.

From one standpoint these factors are of two kinds—chemical and physical; from another, the two factors are rock masses, usually strata, and rock structures, chiefly of a secondary nature. While rock masses furnish chemical opportunity for the deposition, they may also be helpful in a mechanical way.

Strata afford resting places for the ore when their substance can be exchanged for iron oxides, as limestone in many of the Clinton ores and sandstone in others, and as cherty limestone and jasper in the Lake Superior districts. They act as limiting horizons, when as impervious layers they have controlled the downward movement of the water in some permeable bed between or above. This also is a common characteristic of the bedded Clinton ores, such as those of Torbrook and Arisaig, and in part of the Lake Superior ores.

Original structures become factors in the process of deposition, when strata are folded so that the water has gathered in the troughs. To the accomplishment of this result an impervious base is practically a necessity; and when, with these two factors, there is also present a permeable and easily replaceable bed above the impervious basement, a large iron ore deposit may result. This is characteristic of the Marquette district of Michigan.

It is an important point for determination whether it may not be a feature of the Nictaux-Torbrook basin, the ore lying in abundance in the trough of a large syncline, or more probably at a shallower depth in several smaller folds. There is probably no other deposit in Nova Scotia in which this condition is likely to be found; but the size and importance of this basin brings the question of distribution of its ore into prominence.

The secondary structures which may control iron ore deposition are numerous:—(1) a folded dike or sill; (2) the intersection of a dike and an impervious bed; (3) the dying out of joints against a compact and resistant rock mass; (4) the intersections of major joint planes in rocks especially favorable to deposition; (5) zones of rending and shearing in regions subject to mountain-building disturbances; (6) unconformable contacts; (7) one or more systems of regular joints; (8) the presence of irregular fractures. All these give opportunities, in varying degree, for the accumulation of iron ore.

Of the first two Nova Scotia possesses no illustrations, so far as known; but of the remaining, instances may be found in one or another part of the country. If rocks favorable to substitution of iron oxides for their own material are adjacent to or intersected by these structures, the opportunities in favor of accumulation of ore are much enhanced.

Of the fifth, the pre-Cambrian ores of Whycocomagh in part, and of the Boisdale hills (Barachois), are probably cases. The sixth is illustrated by the interesting contact limonites of Pictou county, which are not within the scope of this volume. The third, fourth, seventh and eighth divisions probably furnish a large share of the deposits in the province. Such deposits are large and extensive just in so far as the disturbance which rent the rocks was widespread and effective. Moreover, the presence of rocks which could be replaced by iron minerals under the circumstances that attended the movement of the solutions vastly increases the probability of finding ore in quantity, and in most cases makes the difference between an ore body and a loose network of stringers, films and narrow veins of some variety of iron oxide or carbonate.

Thus, to take two extremes, the Londonderry ore range occurs along a very persistent zone of fissures, which as a whole follows rocks more or less easily replaced. The Logan Glen hematites of Whycocomagh occupy irregular, local, non-persistent cracks, and lie in rocks which were extremely difficult of replacement. In the former there is a very large amount of ore, almost continuous for miles; in the latter a few stringers and pockets of mineral, of a high degree of purity it is true, but with almost no possibility of a large body being present.

Characteristic indications.—In a comparatively undeveloped district there is much uncertainty as to the character of the ore body and its size and extent. The unfortunate tendency to regard every film of hematite as indicating a mass of ore has resulted in many properties being left unexplored, while the owners are on a hunt for a purchaser.

There are certain indications which should be looked upon as unfavorable, and it may be well to mention them. Discontinuity on the strike;

sudden change of breadth; irregularity or vagueness of margin, especially if occurring on both walls; repeated splitting into stringers; apparent lack of definiteness in course; iron ore occurring merely as fillings of distinct and narrow fissures; presence of only coarse sedimentary wall-rocks, such as sandstones and conglomerates—all these are unfavorable where found upon casual inspection of a field.

Iron-bearing waters have had in the past, and have in the present, an exceedingly wide distribution in the shallower portions of the earth's crust. Without going into the chemical causes of the deposition of iron oxides from such solutions, it should be evident that if there are multitudes of opportunities, but small quantities of iron minerals can be precipitated in any one place; and therefore, while in a large area there will be contained a great amount of iron in total, nowhere may there be accumulated enough of the material to make ore. *Ore* may best be defined, perhaps, as metallic mineral of a valuable kind, accumulated continuously to such extent and of such grade as to be workable at a profit. Millions of tons of iron oxides might be present and not come within such a definition. There are several extensive sections of Nova Scotia in which one cannot proceed even a fraction of a mile without discovering some small amount of hematite; but in the whole district there may not be enough in one body to be workable under the present or any ordinary market conditions.

Exploration and Development.

A word may perhaps be said here as to the development of iron ore bodies. Some properties illustrate well, by the method of exploration employed upon them, the points to be avoided in prospecting and developing.

Surface continuity.—First, as to surface extent. A common practice, upon the discovery of an iron ore deposit, is to sink a shaft in it at the point of discovery, regardless of whether it is an especially favorable situation, and to pay no attention to the surface distribution of the vein or other body. In some cases not even its breadth is ascertained. It is rare indeed for any serious attempt to be made to work out the length and continuity on the surface, and yet this is of the utmost importance. For if the ore has not longitudinal surface extent sufficient to indicate a large tonnage, surely its breadth and depth will not be such as to furnish it. One would suppose that the owner, in self-defence, would do everything possible to prove great continuity; but he seems not to regard it as necessary. The first principle then, in opening such deposits as are to be found in Nova Scotia, is to prove the presence, breadth and other characteristics for as great a surface distance as possible. This is true whatever the class of deposit, whether Clinton bedded ore or vein or irregular replacement.

Second, much can be learned during this process as to the probability of the deposit being persistent and strong. The criteria given above will be some aid.

Underground development.—Third, in going into the ore body by shaft, level or adit, except in the Clinton bedded ores, there is no likelihood of being successful with a neat, geometrical system of underground work. Many a venture has been wrecked upon this reef. Experience in the province has shown that, with the exception of the class mentioned above, the outlines of the ore bodies are too irregular to permit rectangular mining. If the walls twist and turn, so must the levels. The only safe policy, whether in exploration or subsequent development, is to follow the walls. In opening up the Iron brook deposit at Skye mountain, Whycocomagh, it was lost entirely for no other reason than that it was thought best, after some excavation, to try to cut the vein at a greater depth by means of a rock adit level.

Fourth, an erroneous interpretation is often placed upon glacial drift in prospecting. The presence of numerous boulders of iron ore does not necessarily indicate a vast ore body, although it may do so. An abundance of narrow veins, economically worthless, might easily produce the same effect in the drift. It is also necessary to ascertain in each district whether the drift was carried to the north or south, or perhaps both, for all three conditions are to be found in the province.

Use of core drills.—Fifth, the practice of exploring by core drills, so universal in the west, is scarcely known in Nova Scotia. The provincial government owns several core drills, both diamond and calyx, and lets them out upon application. But at the most, only a few holes are put down by the owner or bonder, who then thinks he has done his duty. Deposits upon which scores of holes should have been made escape with half-a-dozen or less. In this work a diamond drill is of more value than a calyx, despite its smaller core, because of the inclinations at which the hole may be cut.

There are certain deposits which especially need to have drilling tests, and nothing definite regarding their depth and continuity will probably be known until this is done. While drills are useful for defining length on the strike at a minimum of expense, for proving depth they are invaluable. The great vertical distance to which a deposit may extend is so frequently taken for granted by interested parties, and is in many cases so unlikely, that its proving is of the utmost importance.

Analyses.—Sixth, as to chemical tests. Of all the hundreds of analyses available for various deposits in the province, the larger number are relatively valueless because of uncertainty as to the circumstances under which the samples were collected. In many instances in publications no mention is made of these conditions. A very large number of analyses are made each year from specimens. These latter may be averages of the exposure; but, unless taken by a skilled field man of unbiassed judgment, they are more likely to be too good than too poor. It is indeed difficult, even for one experienced in the work, to take an average sample from many of these deposits. Evidence for this is seen in the difference between ordinary sample analyses from outcrops, or even from an underground working face, and analyses from samples of car load lots from the same face.

Geology of the Deposits.

Rock series represented.—The Nova Scotian iron ores occur in some quantity in the following great geological divisions:—

Pre-Cambrian (George river series).
Cambrian.
Ordovician.
Silurian.
Devonian.
Lower Carboniferous (metamorphic series of Cape Breton).
Lower Carboniferous (conglomerate series).
Lower Carboniferous limestone (Windsor series).
Carboniferous (coal measures, unimportant clay ironstone).
Triassic (trap).
Recent (bog ores).

The other series are apparently without ore, namely:—

Pre-Cambrian (gold-bearing series, also called lower Cambrian).
Carboniferous (millstone grit).
Carboniferous (coal measures for the most part).
Permian.
Triassic (sediments).

Pre-Cambrian.—The pre-Cambrian mountain protaxis of Cape Breton, upon which the whole structure of the island is built, is not sufficiently well known to be subdivided accurately. In the survey of Robb and Fletcher which culminated in the series of one-mile-to-the-inch geological sheets issued by the Geological Survey in various years up to 1885, parts of this complex are differentiated as upper pre-Cambrian, or the George river limestone series, the characteristic feature of which is a light colored dolomitic limestone. So far as known the iron ore of the pre-Cambrian occurs in these rocks. But a large part of the area occupied by the old mountain cores has never been surveyed or prospected in detail; and not only is it possible that the George river series may be far more extensive than is now supposed, but there may be bodies of ore in other subdivisions of the pre-Cambrian. Much geological work remains to be done in middle and northern Cape Breton, especially along the line of exploration for various useful minerals.

The iron ore of the George river series is in part hematite, sometimes apparently bedded, and in part magnetite. The latter is in places distributed in granules through dolomite, being here and there segregated out in sufficient amount to form pockets, of no great promise in any so far discovered. In other localities are larger irregular accumulations, partly replacements of limestone, partly occupying fissures. These are massive ores. All classes of ores in the dolomites look at a distance like impure chromite, and often appear poorer in quality than they really are.

The gold-bearing (Meguma) series, which occupies so large a part of the mainland of the province, contains no workable ores. A few deposits of small size are connected with isolated patches of lower Carboniferous which overlie the older rocks. The known Cambrian, as indicated by fossil contents, is restricted to small portions of eastern and southern Cape Breton, and, so far as known, holds no ore, except in one place. In upturned limestones and slates near Barachois, Cape Breton, are specular and massive red hematite and siderite, roughly conformable with the stratification, and lying on both sides of a contact with lower Carboniferous strata. They have not been sufficiently explored to indicate great size.

Ordovician.—This series, called Cambro-Silurian in earlier studies, occupies large and irregular areas in the north-eastern portion of the mainland, in Antigonish county. It is doubtful whether some parts of the country marked as of this age should not be regarded as Silurian, but it makes little difference in this connection.

The ores now known are chiefly in the vicinity of Arisaig, and are bedded hematites, looking like ordinary Clinton ores for the most part. They are less regular than the bedded ores of the Silurian in size, composition, distribution and relation to the country rock.

Silurian.—In Antigonish county a large basin of Silurian at Arisaig holds a few beds of hematite parallel with the strata. In Pictou county are many veins, partly hematite, partly siderite, which will be considered in volume 2.

The greatest development is in the west, in Annapolis county, and includes the most promising deposit in the province so far opened. This is the bedded hematite series of Nictaux and Torbrook, and a small but perhaps important area at Clementsvale, of similar character. The former contains the only ore which has been proved to any considerable depth, having been cut with calyx drills at 620 feet on the Lean Hematite vein, and worked to approximately 340 feet on the Leckie vein, most of it below sea-level.

Devonian.—By far the most widespread ores are those of the Devonian, being found from eastern Cape Breton westward through the southern part of that island, through Guysborough and Pictou counties and into Colchester and Hants counties, the one north of Cobequid bay, the other south. Indeed the westernmost occurrences are far into Cumberland county, along the south side of the Cobequid mountains.

These ores are varied in their character. In parts, especially in Guysborough county, they are high-grade specular hematites, but apparently in small detached bodies. In Colchester county are the Brookfield deposit and the Londonderry range. The former is an irregular lode of 40,000 or more tons of limonite, occupying the Devonian slates immediately below their contact with the lower Carboniferous; but instead of lying along this contact the lens stands on edge, as it were, extending directly downward into the slates. The Londonderry zone of ankerite (lime-magnesium-iron carbonate) and limonite has been a centre of interest for many years, in part because of its almost unique character. The iron ore is an alteration from carbonates, the complete series being (1) limestone and calcareous quartzite, (2) siderite (iron carbonate), (3) ankerite, (4) hematite and limonite, the last itself passing through several stages. The location of the ore is a series of easily replaceable beds that have felt especially severely the mountain-building which has given the Cobequids their present character.

Lower Carboniferous and Triassic.—Iron ore deposits in the limestone (Windsor series) are not abundant, but the contact deposits of Bridgeville and Sunnybrae, Pictou county, are replacements of limestone at the contact with older rocks, the ore going only to a moderate depth. The contact presents an irregular, broken or zig-zag line, and the iron ore pockets, which are crescent-shaped in surface plan, occupy the apices of the limestone scallops.

Part of the deposit at Barachois, Cape Breton, is in lower Carboniferous conglomerate; and here and there, as north of Whycocomagh, small amounts of hematite occur in the so-called metamorphic series.

The Triassic has many small and isolated magnetite and hematite bodies in the trap, but few are of economic value, because of their limited tonnage.

Thus it will be seen that the iron minerals of Nova Scotia have a distribution as wide geologically as it is geographically. There is, in the province as a whole, a very great amount of iron oxides, but only a small portion of the total number of occurrences are likely to prove workable at any time on a scale which should command the attention of capital.

CHAPTER 4.

MINING POLICY.

CONTENTS OF CHAPTER 4.

Cost of labour.—In comparing the possible productiveness of mining countries, cost of labour is an important factor.

A cost sheet supplied by a large worker in iron ore in Nova Scotia gives the present wages for mining and quarrying as follows:—

Quarryman or underground miner	per day	$1.40—$1.50
Drillman	"	1.75
Ordinary fireman	"	2.00
Foreman, per month		65.00
Expert engine man and mechanic, per month		75.00

This may be compared with Wabana—$1.10 per day for unskilled labour, and $1.50 for drillmen, up to May, 1907; at that time wages rose materially.

All these costs seem extremely low to a westerner, yet they are 25 per cent higher than a few years ago. But while they may mean no less in annual savings to the labourer, owing to difference in cost of living, these low wages do make an item in favor of a low total cost of production of the ore in the province.

As against this item, however, must be set off several others. One is the small size and uncertainty of many of the deposits. Where they are large and permanent they may be uncertain, as at Londonderry; low in iron and high in silica, as at Arisaig; or moderately expensive to work, because of attitude and depth, as at Torbrook. Still, while costs as low as at Wabana or in the Lake Superior region cannot be expected, it should nevertheless be possible to mine ore in a number of parts of the province not now producing, at an expense which meets market conditions; and the author believes that this will be found to be the case.

Some of the labour is unionized, much of it is not. It is difficult to secure or to keep a good quality of miners in this industry in sufficient numbers to meet even the present need. Metal mining of all sorts has been for some years conducted on so small a scale as to turn out few men who thoroughly understand the work. Imported labour has thus far proved more or less unsatisfactory. Indeed, of all the immigrants arriving at the port of Halifax every year, but a handful remain in the province of Nova Scotia.

Capitalization.—One of the most serious drawbacks to any success which might otherwise come to the iron industry of the country is the financial method employed in certain instances by the owners of the land, holders of iron ore leases, middlemen, self-styled financiers and all concerned in the movement to boom a tract of iron ground.

Time and again have owners of land on which the iron ore was not reserved to the crown held out for most exorbitant prices for territory not even properly explored, much less developed. If, instead of attempting to market these properties at unapproachable figures, serious effort were made to work them individually and to get what profit is possible while the ore lasts, more prosperity would result.

A large number of the iron ore deposits of the province are such, in extent and quality, that no ethical sanction can be gained for the practice of large capitalization. It is even an open question whether it would pay existing smelting companies to buy them up. But if, instead, the individual owners were to develop them and contract for sale of the ore to the smelters, if necessary attempting an understanding with one of the smelting companies whereby the latter supplies the tools in instances in which the owner has no capital upon which to work, even under the present market conditions a number of the isolated deposits could be profitably opened up. This plan is known to be feasible, because it is in practice to-day.

The wisest method for working the small deposits, then, is individual ownership and tonnage contract with the smelters. This is now employed by one of the companies for a considerable amount of ore each year.

Smelting centres.—Mention was made in chapter 1 of natural geographic divisions into which the iron ore regions of Nova Scotia group themselves. Of these the eastern section requires little comment. There is no immediate probability of any Cape Breton deposits developing to such size as to require or permit local reduction.

The east central division requires further study before much can be written about it. Some years ago a smelter was erected at Ferrona, in Pictou county, and the steel mills at Trenton, north of New Glasgow, later came to handle its pig. This furnace used Pictou county and Brookfield ores, which all have proved to be local and limited; and on account partly of the development of its Bell island deposits in Newfoundland, the Ferrona works were dismantled, and the large smelters at Sydney Mines erected by the Nova Scotia Steel and Coal Company. How much iron ore could be depended upon within the field outlined on the map as properly feeding this centre it is impossible to state without study subsequent to the preparation of this volume. At present the only large deposit known is that of Arisaig, part of which would not pay to work under the present conditions of market and metallurgy. But the possibility must be kept in mind that in the future it may be feasible again to erect a plant in the vicinity of New Glasgow, where fuel and flux can be assembled with the iron ore at a minimum expense.

There remains consideration of the west-central and western regions. At present the former is drawing upon three sources—the Londonderry range, Torbrook, and, to a small extent, Brookfield. If the Clementsport ores should be found of sufficient grade upon proper exploration—which, by the way, they have never had—they are as suitable as Torbrook ore for the furnace, and of the same variety and characteristics. They are nearer Annapolis than is Torbrook, and they naturally become a part of any large proposition looking to the development of the western ores.

The Londonderry ores are difficult to work upon a sufficiently large scale, without the aid of Torbrook or some other deposit. The capacity of the latter remains to be seen, but it will be by far the largest in the province unless some new deposit of great extent is discovered. Speaking entirely impersonally, without regard to the financial arrangements involved in the present ownership, but only upon the basis of the natural conditions, it seems as though Parrsboro offers a most suitable site for a plant of large size.

To it could readily be brought the ores from the whole western Cobequid range directly. Annapolis is, according to plans already on foot, to be a shipping port for the Nictaux-Torbrook field, and Clementsport would feed this as well. Brookfield is but eight miles from Truro, and with a Truro–Parrsboro railway, survey for which has been made and charter issued, it is within as easy reach of that town as of Acadia Mines (Londonderry) to-day. The Hants county deposits also would reach Parrsboro as easily as Acadia Mines.

Flux would come from the Londonderry range (ankerite) and from Hants and Colchester counties, especially at and near Windsor (limestone). Fuel would come chiefly from Springhill, along the road over which most of the tonnage now goes, giving a short down-grade haul and avoiding the costly and roundabout freightage across the Cobequid mountains, now necessary on the Intercolonial railway. The road from Springhill mines to Parrsboro crosses the mountains by a very low pass, which involves no heavy grades. Should the buried western section of the Cumberland coal field be developed, there would be one or more additional sources of fuel at close range.

It is a large enterprise even under present conditions; but it appears as though it might be possible, and is worth investigating by capitalists. It is the only case of its kind in the province which would not require long and costly exploration of iron fields before being regarded seriously.

CHAPTER 5.

BOUNTIES UPON NATIVE IRON ORE PRODUCTION.

CONTENTS OF CHAPTER 5.

Methods of direct aid.—A certain type of economic requirement is met in one or more of three ways—by tariff on imports, by bounties upon production, or by export duties. This economic need is the protection of a people against the competition of others who are more favored in the conditions under which they labor, and consequently are able to produce either the raw material or finished product at such cost as to undersell their competitors at home or abroad.

An import tariff is adopted by almost all nations; but it is frequently felt to be unwise, especially in a large and young country, to tax raw material in this way. Export duties are rarely resorted to, and only as a drastic measure. Bounties are being increasingly offered, with a view to stimulating the conversion of raw material into finished products at home. Whether or not they are ever justifiable is in part a matter of opinion; but the fact that they are widely employed in the Dominion of Canada makes it reasonable to inquire as to the actual or probable effects of this system in stimulating iron ore mining. The case for iron is strong, if anywhere, in such parts of the country as have many small deposits but few large ones; and of this class Nova Scotia is a conspicuous example.

The thesis that is maintained in this chapter is that a direct bounty upon raw iron ores mined in Nova Scotia, accepted at a Nova Scotian smelter and there converted into pig, would benefit to a very appreciable degree a large population, would circulate money widely among a class who do not receive too much at present, and would not in any way injure the smelting companies, but would, on the other hand, aid in their growth.

Conditions affecting ore production.—First, as to the conditions surrounding the ores themselves. As has been shown in previous chapters, (a) there are few very large deposits of such known size and quality as would insure a large output for a sufficient number of years to warrant the erection of new iron and steel works; (b) there are many small deposits, a number of which are already well enough known to indicate that they could supply a small amount of ore to a smelter, provided prices were such as to make mining profitable; (c) these deposits are almost invariably so situated that for most of the ore considerable transportation would be required to any smelter likely to be erected; (d) the grade of such large deposits as are now known is low, and that of small deposits varies much, but at present no large high-grade ore bodies are known in the province; (e) in many, perhaps most, of the ore localities the cost of mining is not especially low, the high dip of the ore bodies and low topography and the necessary hoisting of ore and pumping of water being some of the factors in raising the figures; (f) there are but two locations in the country which at present appear likely to be favorable for the erection of large reduction works.

Second, the conditions under which the hematite occurs at Bell island, Newfoundland, on the other hand, are especially favorable. The ore is interbedded with the strata. The beds now worked, two in number, lie at a low dip and are so situated that large amounts were extracted by open-cut methods at an extremely low cost. Since underground mining has become necessary the expense is greater, but still low. Owing to the dip, a very large amount of ore can be extracted before sufficient depth is reached to give any substantial increase in cost of production from that source. The location is such that loading for water transportation can be accomplished very cheaply, and the freight charge to Sydney or North Sydney is small.

Third, the cost of labour is less in Newfoundland than in Nova Scotia. Unskilled labour has been until recently $1.10, as against $1.35 to $1.50, and drill men $1.50 as contrasted with $1.75 and $2.00. The result of all these conditions is that Bell island ore can be delivered at Sydney or Sydney Mines at a fraction of the cost at which that from Torbrook and Brookfield can be obtained at Londonderry. The latter ore has been sold by contract for $2.75 at the smelter.

In addition to this handicap upon native ores, there is a difference in percentage of iron. An average of the upper bed at Wabana at present is 52.65, of the lower bed 48.00. Compared with this, the Wheelock mine at Torbrook averages 43.00 and is higher in insoluble and in phosphorus than the Wabana ore. The Leckie ore averaged 51.72 in iron; and this lends encouragement to recent developments on this bed in the western part of the field.

Present aid to manufacture of pig iron.—To offset slightly these discrepancies, the Dominion Government now pays a bonus of $2.10 upon each ton of pig made from native ore, and $1.10 upon each ton made from foreign ore. This would amount approximately to $0.90 bonus on a ton of 43 per cent ore, $1.00 upon 48 per cent ore, and $1.09 upon 52 per cent ore. An additional aid is at present furnished by the Nova Scotian Government, in the form of a rebate upon the royalty for coal used in smelting iron. It amounts to \$0.05 per ton of coal in the case of the Londonderry Iron and Mining Company and Nova Scotia Steel and Coal Company, and \$0.0625 for the Dominion Iron and Steel Company. This is an individual difference; and as there is no distinction made between coal smelting foreign ore and that smelting native ore, this factor does not influence the problem under discussion. A bounty system inaugurated on a decreasing sliding scale in 1897 expired in June, 1907. This began with a bonus of \$3 per ton on iron from native ore, \$2 upon that from foreign ore, and \$3 upon steel.

According to the new tariff schedule recently put in force, direct aid to the iron industry is as follows, based entirely upon the production of pig: for 1907, upon pig from native ore \$2.10; for 1908, \$2.10; for 1909, \$1.70; for 1910, \$0.90; upon pig from foreign ore for 1907, \$1.10; for 1908, \$1.10; for 1909, \$0.70; for 1910, \$0.40. Upon iron bars and steel ingots the bounty for 1907 is \$1.65; for 1908, \$1.65; for 1909, \$1.65; for 1910, \$0.60. All bounties cease at the end of 1910, unless renewed, as has been done twice already.

Effects of present system.—That this bounty system has been a marked stimulus to the mining of iron ore in Nova Scotia not even the most sanguine would assert. It has accomplished that for which it was intended; it has made possible the building up of a great steel industry. No criticism can be directed toward the plan upon this basis; but the result has been accomplished not with native but foreign ores, and under it no appreciable amount of Nova Scotian iron has been used by the two steel companies.

The Londonderry district has been worked for a few years under the provisions of this bounty, but its governing conditions are exceptional. The furnace is so located that it must of necessity use native ore. In addition, it is able to employ an iron-bearing flux, so that it can accept a lower grade ore than otherwise would be financially possible. And finally, the ore is not reserved to the Crown, hence no royalty has to be paid.

Attitude of steel companies.—The great difference in cost of production between the Wabana and native ores, the small size and uncertainty of yield of much of the latter, and the great size and continuity of the former, create a degree of satisfaction with present conditions on the part of the large companies which makes them unlikely to take the initiative to any extent in searching for native ore. But, on the other hand, they are not in any way hostile to native ores as such. There seems to be an idea through parts of the province that the local steel companies deliberately shun native ores. Nothing could be further from the truth. Corporations are not swayed by sentiment, but by the sense of profit and loss. What the history of iron mining in Nova Scotia would have been but for the discovery and purchase of the Bell island deposits, none can say. Very likely it would have included the opening up of many of our deposits; certainly it would have developed a smaller steel industry than is now possible, and as certainly it would have induced a higher cost for iron and steel and their products.

The steel companies are merely proceeding upon an obvious business principle—getting their raw material where it is least expensive. They are able to import ore at an extremely low expense. They can do this without great increase in cost, for a considerable length of time. And finally, contrary to general opinion and current rumor, they have probable reserves sufficient to carry them forward for many years.

So far from shunning native ore, these companies will accept, up to the full capacity of the producers, any and all ore offered at the smelters by local miners and from Nova Scotian mines, if acceptable in quality; and for this ore a fair market price will be paid.

Proposed remedy for inactivity.—Since one form of bounty has not produced the effect desired, it remains to see whether another method is more likely to succeed.

It is the belief of the author that a bounty upon native iron ore, at a sliding rate dependent upon quality, when that ore is accepted at a Canadian smelter and there converted into pig, will be as effective an aid as can be devised.

Such bounty need in no wise be deducted from whatever is to be paid as bonus on iron and steel pig. Instead of doing injury to the steel companies it will benefit them; for an increase in the use of native ore will increase their bounty receipts upon the pig.

It is a reasonable view that any aid which can legitimately be given the miner of the ore, to enable him to meet the competition of Newfoundland ore, is due him as a matter of simple justice. It will enrich the province by increasing activity in labor, and especially by putting large amounts of money into circulation where now is stagnation, scattering this money widely among a class never too highly favored in the struggle for existence.

Method of application.—Such a bounty can easily be arranged so as to do justice to the vendor of low grade ore as well as to the exploiter of high grade ore. There are many places in the province where iron in some amount can be found—which is, indeed, one of the difficulties in the way of large scale exploitation. The high grade ore is, as far as now known, pockety and uncertain, so that the tonnage of a deposit is small and cost of production correspondingly high. On the other hand, a few low grade deposits are large.

A properly adjusted sliding scale can be devised which would make the payments for any ore fair, no matter what the iron content—for a low grade ore, a smaller payment; for a higher grade, a larger payment. To have a concrete illustration, suppose that the bounty were one cent per cent—that is, for 50 per cent ore 50 cents, for 45 per cent ore 45 cents, and for 55 per cent ore 55 cents would be paid; no ore below 40 per cent to have a claim, and an especial bounty upon ore of 60 per cent and over. If the other ingredients of the ore were not satisfactory it naturally would not be accepted. The figures given above are not advocated, but are employed merely for illustrative purposes.

Again, no ore need be given a bounty unless delivered and accepted at a local smelter, the payment to depend upon the endorsement of the purchasing agent or engineer and the chemist for the smelting company. Thus no vision need disturb one of a great amount of ore raised to the surface merely to secure a bounty and left there to rot.

Automatic operation.—Such a method would cost the Government nothing, except as it accomplished the end for which it was planned. Only upon ore which is actually turned into pig would payment be made; thus all ore that is given the bounty becomes part of the assets of the country. Only directly in proportion as the scheme is useful, in proportion as it enriches the country and stimulates industry, will it cost—and no more. Few systems of direct financial aid are so automatically operative.

Criticisms.—Criticisms of the plan have been few but often repeated. They may be summarized as follows:—(1) ore will be raised purely for the bounty and not used; (2) ore will be raised and exported, the country not receiving financial benefit; (3) the plan will fail to stimulate activity. The first two are treated above. For the third, if the plan fails it at least costs nothing, and will only be following the failure of the present system.

Need for a new system of aid.—The history and present condition of iron ore mining in Nova Scotia are strong testimony to the inefficiency of any aid previously offered. The proposed change would benefit any existing smelting works, but would also bring closer the possibility of other reduction works.

Some who have discussed the question have considered only the present steel works, both at the extreme east end of the country, and a smaller iron furnace in the centre. But the fact must be borne in mind that there is at least one other district which is in many ways favorable for a smelting centre. The proximity of the three ingredients—coal, lime and iron—must determine the location of such a plant; and, with a number of small deposits and one large one to feed it, the erection of a new smelter may be feasible, following certain changes in economic conditions. Each centre would drain ore from a large field, and together they would cover the country.

Special advantages.—The special advantages which a system of direct bounty upon raw ore would seem to possess are :—(1) it bids fair to succeed where the present system has had no effect; (2) it is automatically operative, costing only in proportion to its efficiency; (3) it places upon the owner of the ore the incentive to initiate a bargain with the iron master. The last is in many ways the most important point. It has been remarked that, under the present system, there is little incentive on the part of the smelting companies to look for ore in the province. Under the proposed method, even if the final result of bargaining were financially little better for the miner, he would be led to take the initiative himself and to approach the possible purchasers. With the two parties in contact, certainly there is much more probability of business being done than if they did not come together.

PLATE No 12

Plan
of
Iron properties held by The Annapolis Iron Co., Ltd.,
and The Londonderry Iron and Mining Co. L'td.,
Torbrook, Annapolis County,
Nova Scotia.
Scale of Feet.
Reference.
Pits, Trenches, and shafts, shown thus
Iron occurrences reported
Torbrook
Mill Pond
Black River
Nictaux Falls
Halifax & Southwestern Railway (Central Division)
County Line
Townsend Line
Base Line
Forest
Londonderry Iron & Mining Co. L'td. Lease

CHAPTER 6.

TITLES TO IRON ORE.

CONTENTS OF CHAPTER 6.

SYSTEMS OF HOLDINGS.

Two systems.—In Nova Scotia two systems obtain, under which iron ore is held as property. The situation, which is almost hopelessly involved in some localities, has been explained as clearly as is possible by the late Dr. E. Gilpin, Jr., Deputy Commissioner of Works and Mines of Nova Scotia (Mineral and Crown Land Grants in Nova Scotia; Trans. Roy. Soc., Can., vol. IX, 1903, pp. 123–134).

In some parts of the province title to the iron ore remains vested in the land; in others the iron is reserved to the Crown, and in certain districts both systems obtain, to the great confusion of titles. The exact condition depends upon the date of the original grant of land and the nature of the clause contained in it reserving certain minerals.

Earlier grants.—In grants up to the year 1808 no reservation of iron ore was made by the Crown, but from that year onward reservation was a feature of the grants. "It follows therefore that, in many of the older township grants issued between 1759 and 1785, the Crown does not profit by the mining of this ore. This is notably the case in the grants of Guysboro, Londonderry, Nictaux and Clementsport, and in numerous large blocks of land granted to the Loyalists and early Scotch settlers in Antigonish, Pictou and Colchester counties." In all of these, title to ore is vested in the land, and no royalty is paid to the Provincial Government on the ore.

In 1826 a royal grant was issued conveying to the Duke of York and Albany all the mineral rights of every description in the province, except those previously issued and in process of working. The rights were transferred to an organization in London, known as the General Mining Association, which kept them until 1858, at that time releasing to the Provincial Government of Nova Scotia all rights except those to certain tracts of coal land. Thus all rights to iron ore, except certain early grants, came under control of the province. These rights included those in ungranted lands, in lands granted between August 25, 1826 and the date of settlement in 1858, and in all iron reserved in lands granted previous to August 25, 1826.

Acts of 1858.—The acts of 1858, chapter 2, next came into force, reserving gold, silver, copper, lead, tin, iron, coal, and precious stones, and leaving all other minerals unreserved. This continued in force until 1892, when all minerals, except limestone, gypsum and building material, became reserved.

"At the present day the procury of title to minerals which are the property of the owner of the land is attended with much difficulty. Loose occupation, imperfect descriptions, non-division of property, squatters' titles, etc., confront those charged with the task of searching titles for would-be purchasers. It will be necessary for the Government to devise legislation which, while preserving equitably whatever mineral rights the owner of the soil may be entitled to, will give to investors the security of title enjoyed by those acquiring leases of Crown minerals."

Cape Breton island.—In Cape Breton, while most of the iron ore is reserved to the Crown, some is not; and as the history of that country is most complicated, and is different in the early years from that of Nova Scotia, it is inadvisable to attempt here to explain the conditions. They can only be learned in the specific cases when attempt is made to get title to the ore.

Records.—In the office of the Department of Crown Lands in Halifax the grants are recorded in two series of books. One of these is numbered, the other lettered. In general it may be said that iron is *reserved to the Crown* in the grants which are labelled on the Department maps as referring for description to books designated by *letter*, and in the *numbered* books it is not reserved. More specifically, however, iron ore is reserved in those grants recorded on the maps as of books A to Z, except part of book R, and books 12 to 64.

The Crown Lands office has maps and records only of the original grants. For all information regarding present ownership search has to be made in the various county registry offices, a slow and uncertain process. The system is by no means perfect. It is often difficult to discover the present ownership, or to find accurate maps or descriptions from which one can do his own surveying.

Ownership and promotion.—Taking advantage of the condition of ownership of such iron ore as goes with the land, a common method among promoters, in order to secure such title as will enable them to work off a sale at their own convenience, is to procure from the owners of the land an option, paying a small deposit, $50 to $100, the option binding the owner to sell at a specified price but neglecting to bind the purchaser to buy within a specified time. The balance of the payment is to be made when the promoter closes his mining deal. Cases are not uncommon, if reports be true, in which the owners, after waiting a considerable time for the first bonders to put this deal through and make payment, have yielded to the persuasion of a new-comer, rebonding the property indefinitely and receiving another small advance payment therefor. Meanwhile, because of the wording of the option, the first bonder's legal hold on the property continues. Thus the difficulty of a final purchaser, ignorant it may be of the earlier history of the case, is very great in securing a clear title. The involved condition may easily discourage an investor and result in a failure to buy.

Unfortunately, it is much to the interest of any promoter to get an option upon mining properties which shall omit any time limit. The only gain which the owner would seem to derive from such a bargain is the opportunity to secure a second small initial payment, should a new adventurer arise. But this gain would appear to be slight, contrasted with the probable failure to consummate any final sale to which the dishonest practice described above leads.

Leasing from the Crown.

As the information contained in this report is in part for those outside the province of Nova Scotia, the following general description is given of the procedure in acquiring rights to iron ore reserved to the Crown.

Licenses to search.—The mining districts are divided into areas of five square miles each, in shape 2.50 by 2.00 miles. In a new district the Mines Department will locate areas upon application. For any number of these areas licenses to search may be taken out at the Mines Office. For all purposes of license and lease, every area is composed of five unit rights, each containing one square mile, and the applicant receives one, two, three, four or five rights to search, according to his application. Should he apply for but one right, and no one is before him, he is given a first right; should he apply for two, they are first and second rights, and so on through the five. Should he not apply for all the possible rights, anyone else is at liberty to make application for and to receive any or all of the remainder.

Conversion to leases.—On or before the expiration of eighteen months the licensee must exchange the license of his first or otherwise earliest right for a lease of one square mile.

This, if he is exercising a first right, he may choose from any part of the area, but its length must not be more than two and one-half times its breadth. This exchange he must continue to make at intervals of eighteen months or less, until all his rights are exhausted. If he does not possess all five rights, the rights of any later applicant are convertible in due course of time and in order, after his own have been exhausted, until in all five rights have been converted into leases. This would take seven and one-half years. Whenever a first right is converted into a lease, but four are left, and what was a second right becomes a first right. This change of numbers recurs at each conversion.

Lapsing of licenses.—There is one method that may be employed, if one does not desire the expense of a lease at the time and is not working the property. Upon the expiration of the eighteen months the first right, if unconverted, lapses; the second becomes the first, and so on, leaving the fifth right vacant. The applicant may immediately, at 10 a.m. of the day following that in which the first right lapsed at close of business, make application for the vacant fifth right. But as some claim jumper—of whom there are not a few—may apply simultaneously, or a moment ahead, the proceeding is a dangerous one.

Costs and tenure.—The cost of a right to search is $30, or $150 for the whole area. This is a single charge, and the privileges which it confers last throughout the whole seven and one-half years without additional expense chargeable to the licenses themselves. The leases cost $50 per square mile for the first year, and $30 per square mile per year thereafter. The lease runs for twenty years, subject to three renewals, so that an operator may control iron lands from the Crown consecutively for eighty years. The fees for leases may be paid yearly, or for the whole twenty years in advance.

PLATE 7.

GENERAL INDEX OF SYMBOLS.

T.	TRIASSIC SEDIMENTS.	Or.	CAMBRO-SILURIAN (ORDOVICIAN)	Gr.	GRANITE.
C2.	MILLSTONE GRIT	Є.	CAMBRIAN.	□	LIMESTONE. (PLATE I.)
L C2.	LOWER CARBONIFEROUS LIMESTONE.	M.	MEGUMA. (GOLD BEARING SERIES)	△	DOLOMITE. (PLATE I.)
L C1.	CARBONIFEROUS CONGLOMERATE.	PC1.	GEORGE RIVER SERIES.	○	IRON (PLATE I.)
D.	DEVONIAN.	PC.	UNCLASSIFIED PRE-CAMBRIAN	■	PITS AND SHAFTS.
S.	SILURIAN.	Tr.	FINE TEXTURED INTRUSIVES.	●	IRON OCCURRENCES.

PART II.—DETAILS OF IRON DISTRICTS.

CHAPTER 1.

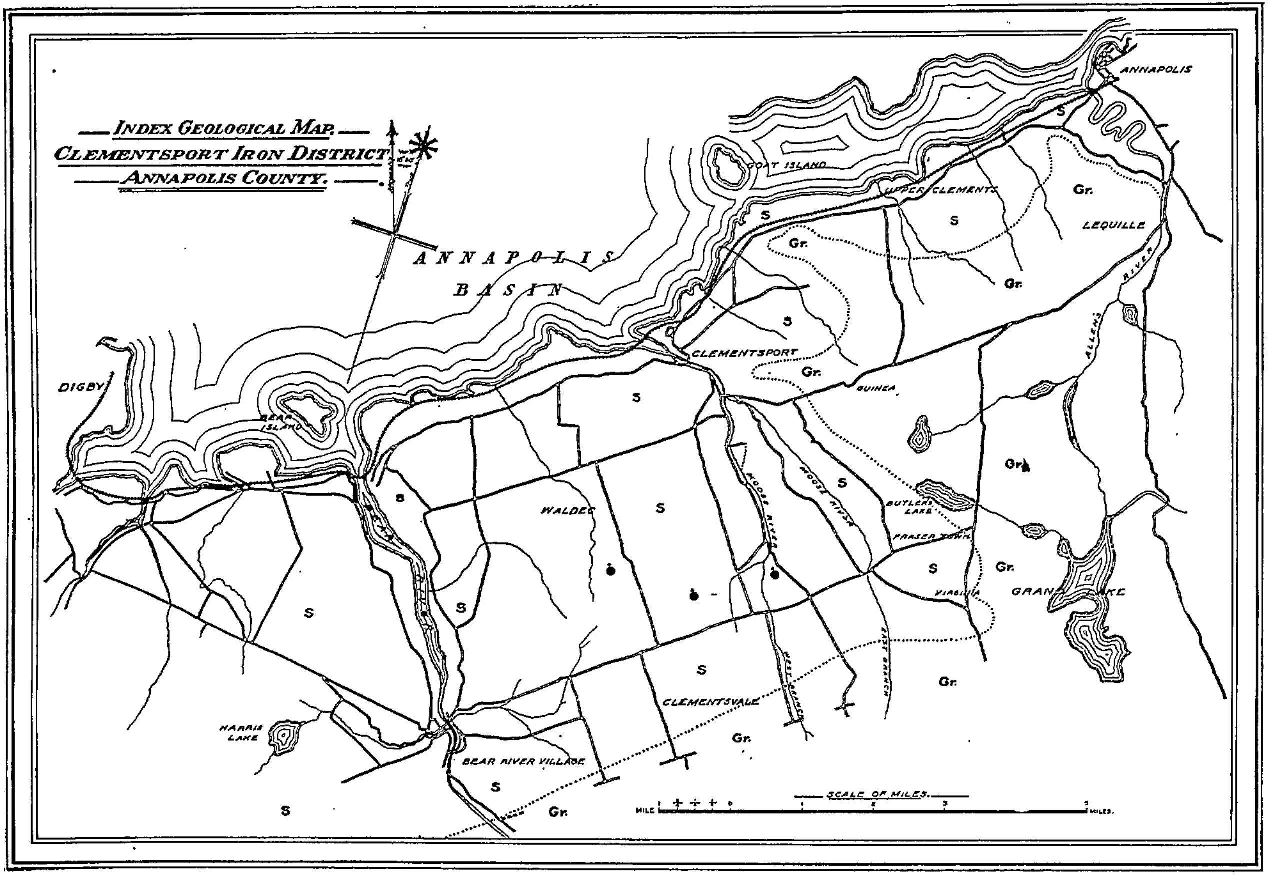
THE CLEMENTSPORT BASIN.

Contents of Chapter 1.

Location and extent.—Besides the large Silurian basin of Nictaux-Torbrook, there are two to the west. One of these is the Clementsport-Bear river basin, the other a very small Silurian area east of Weymouth. The latter need not be referred to further. The former, although never thoroughly explored, has long been known to contain at least three occurrences of iron ore.

The basin extends from a point east of Clementsport for twelve miles to the southwest, and has a maximum breadth of three miles. Its general surroundings are shown in Plate 8. The only general survey of the country, that of Bailey, regards the rocks occupying the shores of Annapolis basin and thence inland for two to three miles as older than the iron-bearing formation at Clementsvale, and as part of the Meguma (gold-bearing) series of the province. Structural studies of the present author, made for the most part previous to the field work upon this report, do not directly bear out this decision. But as these rocks have never been known to carry iron ores, it is sufficient for present purposes to outline the western edge of the Silurian as is done in the map accompanying Dr. L. W. Bailey's report of 1896.

PLATE 8.


INDEX GEOLOGICAL MAP.
CLEMENTSPORT IRON DISTRICT
ANNAPOLIS COUNTY.
ANNAPOLIS BASIN
ANNAPOLIS
GOAT ISLAND
UPPER CLEMENTS
LEQUILLE
CLEMENTSPORT
GUINEA
DIGBY
BEAR ISLAND
WALDEC
MOOSE RIVER
BUTLERS LAKE
FRASER TOWN
VIRGINIA
GRAND LAKE
ALLEN'S RIVER
EAST BRANCH
WEST BRANCH
CLEMENTSVALE
HARRIS LAKE
BEAR RIVER VILLAGE
SCALE OF MILES.
Gr.
S

History of Clementsport Workings.

How early iron was known to lie back of Clementsport is not stated in any of the historical literature.

In 1825 the Annapolis Iron Mining Company was formed, and Mr. Cyrus Alger, of Boston, an iron founder, was employed to erect a smelter. This was located at the head of tide-water on the east bank of Moose river, in the village of Clementsport. The ore came from two of the deposits to be described below, from one of the beds at Nictaux, and in small quantities from several other places. An exceedingly good grade of charcoal iron was made from mixed ores, and some of the utensils cast from it are still in use in the village. Operations were suspended within a few years, not to be resumed until about 1861. In 1862 an output of five tons per day was attained, but within a year or two the works were shut down.

How much work was done in the next decade, if any, cannot be ascertained. In 1872 one of the deposits, the Potter property, was re-opened and the furnace ran for ten weeks, using 600 tons of ore, 1,000 tons being raised. In 1873 the furnace ran for six weeks, during which 538 tons of ore were mined at Clementsvale and 630 smelted, the balance being largely bog ore from Bloomfield, a settlement to the south-west. In 1874 the properties passed into the hands of the New York and Nova Scotia Iron and Coal Mining Company, which, however, never seems to have done work upon the mines. Since that time there has been no activity. In 1885, 13 tons of ore are reported to have been sent to Londonderry from Annapolis, doubtless coming from Clementsport.

Description of Openings.

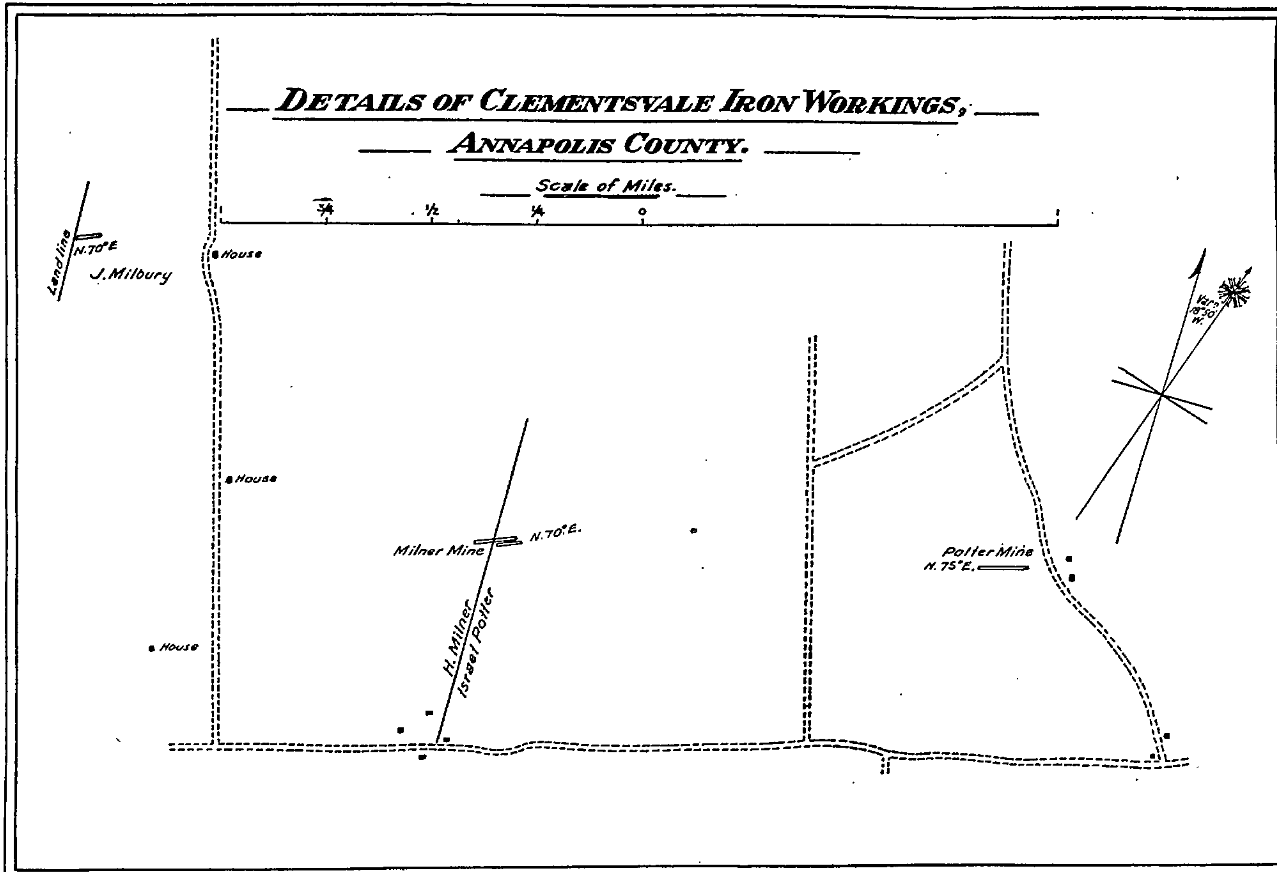
Potter trench.—The easternmost of the three workings at Clementsport is the Potter mine, on the property of Wm. Brown. This is a trench in a field west of the direct road between Clementsport and Clementsvale, and about one-half mile north of the crossing at the latter village.

The large scale map (Plate 9) gives its position. Its strike is N. 75° E. (magnetic), parallel with the back road between Annapolis and Bear River village, the deposit dipping 75°–80° S.E. The total excavation is 390 feet in length, averaging 20 feet deep at the south-west end and perhaps 15 feet at the north-east end. The opening shows clean slate walls 8 ft. 9 in. apart. On the eastern end recent working exposed a total breadth of 7 ft. 6 in. at 16 feet depth.

The state of the excavation has made close inspection impossible. The section given by Gilpin (The Mines of Nova Scotia, p. 55) is:—

Ore	3′–0″	
Slate parting	2′–6″	
Ore	3′–6″	total 9′–10″

PLATE 9.



DETAILS OF CLEMENTSVALE IRON WORKINGS,
ANNAPOLIS COUNTY.
Scale of Miles.
3/4
1/2
1/4
0
Land line
N.70°E
J. Milbury
House
House
House
Milner Mine
N.70°E.
H. Milner
Israel Potter
Potter Mine
N.75°E.
Var. 18°50' W.

Both walls are slate. The parting is said to be 16 inches, by some who have worked in the trench in earlier years; but this may be taken as too narrow, judging by the amount of slate on the dump. Others equally conversant with the conditions have stated that the ore was so intimately mixed with slate as to require cobbing and hand sorting.

No good ore is now to be found, some poor fragments forming the only refuse. The iron is, like that at the western end of the Nictaux field in general and especially parts of the South Mountain ore, a magnetite, altered from a hematite replacement of a fossiliferous bed, probably of limestone. The shells, although infrequent, are the same in kinds as at Nictaux; and on the whole the ore is not more metamorphosed than in some of the western pits of that district. The streak is at times slightly reddish. Fortunately, on the site of the old smelter is a dump in which the Potter ore can be distinguished by its character, looking like fragments lately taken from the east end of the trench. Sample 194* is from this dump. Two published analyses, C-1 and C-2, are also given.

	No. 194	C–1	C–2
Fe	36.72	42.103	58.850
SiO_2	....	....	16.500
Insol.	....	23.073	....
P.	....	.716	.246
S.	....	.180	.395

Milner openings.—These are two trenches, 35 feet apart, on the farms of Herbert Milner (west) and Israel Potter (east). Their relations to the land lines are shown in the large scale map (Plate 9). The north trench is 450 feet long; 250 feet in the former property, 200 in the latter. The south trench is 350 feet long, all in the Potter property.

The strike of these trenches is N. 70° E. (magnetic). Both are filled in and the walls have fallen. The north opening shows walls of slate apparently 3 feet 4 inches apart. The south one is in too poor a state of preservation to show even this. Large amounts of ore lie beside the former trench, evidently of low grade, similar to the Potter ore except in being deeply weathered and obviously of poorer quality and in being practically non-magnetic. From those who had seen the trench when freshly opened, it would appear that the ore is about 21 inches wide and mixed with rock. A published analysis is added (C-3), which would appear to justify this statement.

	C–3
Fe.	32.189
Insol.	33.300
P.	.220
S.	.168

* Mines Branch samples are given plain numbers; analyses from other sources are characterized by prefixing a letter to the number.

Milbury opening.—This is on the property of T. Milbury, on a road running north from the back road mentioned above; a 300 foot trench striking N. 70° E. (magnetic). While the trench is partly filled in, slate walls 3 feet 6 inches apart can be seen. Slate lying north of this vein is highly ferruginous.

The character of the fresh ore and the section of the belt are alike impossible to discover at present. What dump ore is to be seen is soft and black and shows a yellow streak. In every way it appears different, in its present state, from the Potter and Milner ores. Whether this is due entirely to its weathered condition is difficult to say.

Sample 195 is the best obtainable from the dump on this trench. Two Londonderry analyses are added. Their labels are "North vein" and "South vein," and both are called magnetite. This makes one doubt whether they may not refer to the Milner trenches; but the analyses for iron, phosphorus and sulphur are so different from those of Milner ore that it is thought they belong to the Milbury iron. It is known that the latter was highly regarded at the Clementsport furnace and sought for mixing with the eastern ores. About 30 feet south of the trench is a small pit pointed out as an opening on another bed, but nothing could be seen to indicate its presence. This may be the south vein of the analyses.

	No. 195	No. C–4 (north)	No. C–5 (south)
Fe	17.75	60.130	62.690
SiO_2	....	9.100	15.590
P	....	.009	.008
S	....	.028	.025

Structure of the Basin.

Restriction of Silurian.—That the strata toward the shore, in the sections made by Moose river, Deep brook and Bear river, are not the same as those which lie nearer the granite to the south, and which bear the iron, is shown (1) by the fact that they are not the same in kind, (2) by a different structure, and (3) by the abundance of their basic intrusives, particularly in layers parallel to the stratification (sills). North-west, therefore, of the top of the large scale map (Plate 9), which marks approximately the boundary of the Silurian iron-bearing rocks, there is no probability of finding ore. Upon all other sides the Silurian is cut off by intrusive rocks, chiefly granites.

Number of iron beds.—Within the Silurian there may be other strata replaced by iron. There is no probability, however, of much repetition through folding, as in the Torbrook basin, for the dips are all north-east. In the Torbrook basin, moreover, there are but few horizons which contain iron, although folding and faulting have repeated these. Only strata of especially favorable composition would permit this replacement. From various causes, therefore, it is quite possible that there may be no more iron beds in the Clementsport basin than are now opened.

Whether the three mines have been opened upon the same iron beds it is impossible to decide with the slight evidence at command. One only is cut at the Potter workings, but there may be another at the proper distance—30 to 40 feet north-west or south-east. This part of the field is one in which a magnetometer would be of great service.

Extension of iron beds on strike.—The Milner beds are north of the range of the Potter trench, even allowing for the 5° difference in strike, by at least 630 feet. While folding might account for their situation there is no evidence of this, and it seems more reasonable in this instance to infer a right-handed fault With regard to the Milbury opening, in default of any knowledge of the character of the fresh ore it is useless to speculate as to its relation to the rest of the field. None of the occurrences at Clementsvale have been traced beyond the individual openings. Statements in literature on the subject to the effect that the Potter bed had been traced for a mile mean, apparently, that similar ore had been opened upon the Milner property. Nevertheless, these two are of a type which normally should persist for a considerable distance on the strike, and it is not improbable that upon proper exploration they will be found continuous for many thousand feet. The district is similar to Torbrook in every essential, as regards the method of occurrence of the ores, and in that basin two of the ore beds are regarded as being traceable for 13,000 feet at least. Like that district, also, Clementsvale will probably be found to be cut up more or less by cross-faults.

If the Potter vein should extend north-eastward persistently from its present opening, granite cuts it off at a distance of 11,000 feet, which is itself no mean length. Toward the south-west the distance which the vein might go without meeting either the granite or the unconformity which limits the Silurian shoreward is undetermined, because of doubt as to where the contact line runs. It would, however, be south-west of the Milner openings, which are 5,800 feet from the Potter trench. Thus there is a considerable field in which the ore beds may be of value.

Permanence of the deposits.—There is no direct evidence as to probable permanence of the ore in depth. Other fields of this character have shown good ore at a depth of several hundred feet; but in the same district may be cases exhibiting such decrease of iron ratio within 25 or 50 feet downward as to make the mineral unmerchantable. In the absence of any direct information, it is impossible to do more than to point out that the type of deposit represented here is on the whole a stable one.

Development of the District.

Value of the field.—Despite the fact that so little work has been done in the Clementsport iron field, it appears to have considerable promise. With the possibility of a length of nearly 20,000 feet, and with a type of ore usually quite persistent in depth, the district certainly merits examination. As far as can be learned upon inquiry, no systematic prospecting has ever been done here.

Prospecting.—The exploring which would best show the nature and extent of the iron is somewhat as follows. Aside from cleaning and testing the various openings, the extension of the iron can be traced by magnetometer in at least two of the cases. The Milbury ore may be merely a surface form of what below is magnetite; as would be judged from the literature; but for the time it must be left out of account, despite its high assay value, because of lack of knowledge. If indications as recorded by the instrument are favorable, pits may be sunk at suitable intervals for testing and measuring the surface ore. If the magnetic quality of the ore is too feeble in places for the use of the magnetometer, test-pitting at rather frequent intervals along the line of strike would have to be resorted to.

In addition, a line of diamond drill holes should be sunk at intervals of say, 1,000 feet, to cut the ore at various depths if it be persistent downward; and the cores would give tests of the values.

One possible variable factor has not been touched upon. It appears from the few exposures as though the iron ore may lie on the north side of a syncline, the axis of which could be at least as near as 650 feet to the south. If this were the case, however, the turning point of the dip of the Potter ore would still be far below any ordinary mining depth. But should the centre of the fold be still nearer, the possible depth of working would decrease rapidly. A safe method of ascertaining whether the iron deposit goes to such depth as to make a large scale proposition would be to locate a drill 400 feet south-east from the Potter opening, sinking toward the ore at an angle of 60° from the horizontal. If the dip of the rocks remains 75°, this hole should cut the strata and iron horizon at an angle of 45°, which is one less likely to cause rupture of the drill core than some others. Below is a table giving roughly the various distances concerned, for the maximum and minimum dips observed. For a distance of 200 feet between ore bed and drill, the figures below should be divided by two. The length of drill-hole must be considered in ordering one of the local government drills.

	Drill inclined 60°		Drill inclined 75°	
	Ore 75° dip	Ore 80° dip	Ore 75° dip	Ore 80° dip
Vertical depth of ore	480 ft.	535 ft.	750 ft.	910 ft.
Height of stoping ground	490	540	780	920
Length of drill-hole	550	610	780	940

Timber and power.—Should the district upon examination prove worthy of extensive development, both wood and power can be had.

There is no timber for some distance, but within a few miles to the south is both hard and evergreen wood in fair size. Practically all the timber land here, as elsewhere on the mainland, is under control of one or another lumber company, and arrangements would have to be made with these for the supply.

Moose river, upon which Clementsport is situated, would supply adequate power by storage. The water power was not computed, owing to the unfairness of using so high water. But it could be seen that, with adequate artificial facilities for storage, enough power should be obtained for mining and possibly for electric smelting. The power would be taken three and one-half miles from the iron deposit, at the head of tide-water. Any smelter that might be erected would also be placed there. However, there is no reason to expect more than a shipping proposition here, the ore being shipped directly from Clementsport on a small scale by water, or by rail on a larger scale, Annapolis being eight miles distant.

Bear river could be made to yield a larger power from the head of tide-water five and one-half miles from the crossing at Clementsvale. It, too would require careful storage.

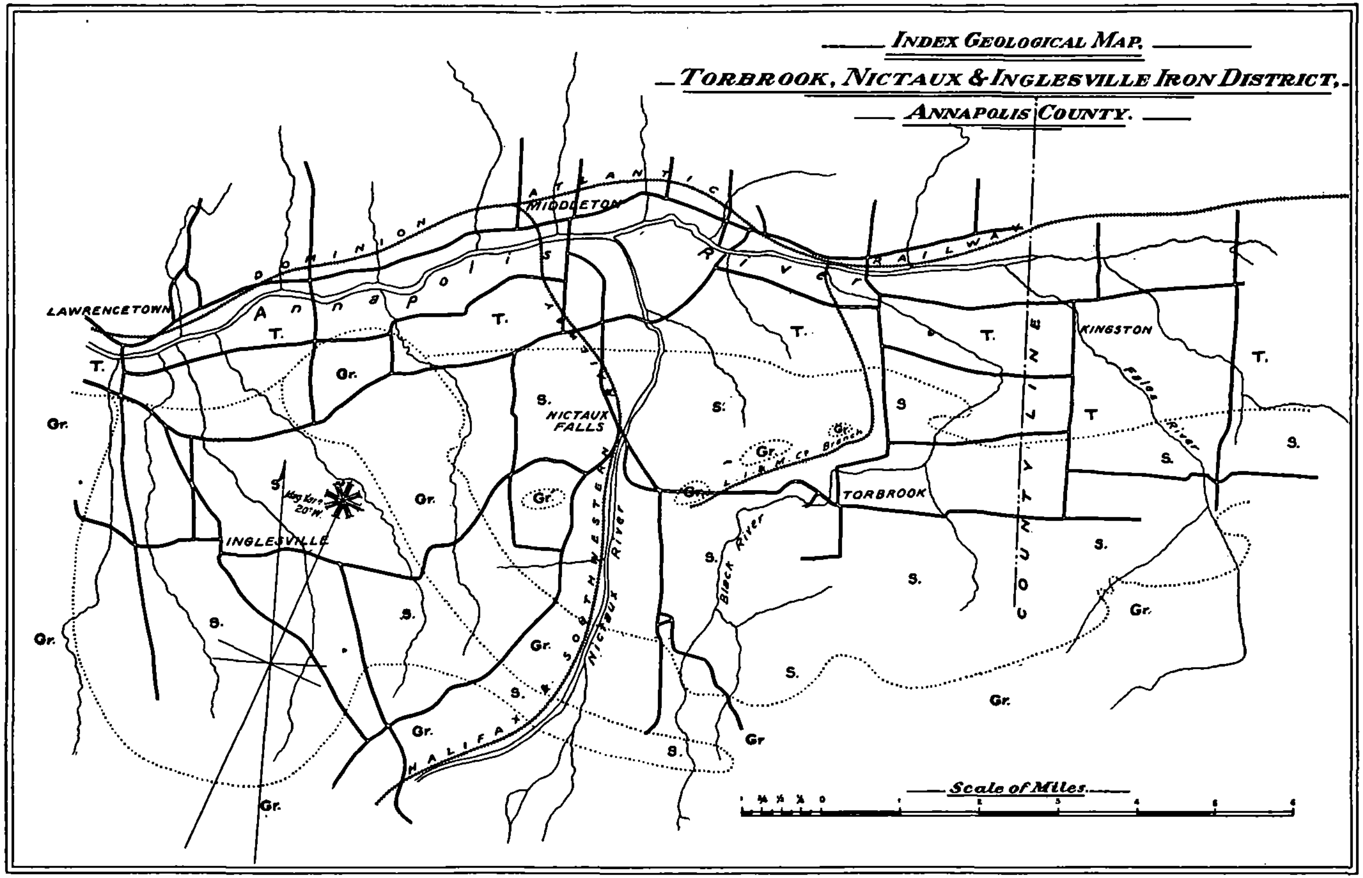
Water rights on all these streams are held by lumber companies.

PLATE 10.

(*a*) Falls of Moose river: Clementsport district.

(*b*) Falls of Nictaux river: Nictaux-Torbrook district.

PLATE 11.


INDEX GEOLOGICAL MAP.
TORBROOK, NICTAUX & INGLESVILLE IRON DISTRICT,
ANNAPOLIS COUNTY.
LAWRENCETOWN
MIDDLETON
NICTAUX FALLS
INGLESVILLE
TORBROOK
KINGSTON
Annapolis River
Dominion Atlantic Railway
Halifax & South Western Ry.
Nictaux River
Black River
Fales River
County Line
Scale of Miles

CHAPTER 2.

THE NICTAUX-TORBROOK BASIN.

CONTENTS OF CHAPTER 2.

INTRODUCTION.

Location, extent and ownership.—The important iron ore field of Torbrook and Nictaux is situated in eastern Annapolis county, on the south side of the Annapolis river valley and against the side of the highland to the south, locally called South mountain. The distance from the old Leckie mine to Wilmot, on the Dominion Atlantic railway, is 3 miles; from the Wheelock mine, 4.8. From Wilmot to Acadia mines, *via* Midland division (Windsor to Truro), 137 miles; *via* Windsor Junction, 153 miles.

It stretches from the Kings—Annapolis county line on the east to the granite back of Cleveland mountain on the west, a distance of seven miles. Its breadth is in places 15,000 feet from the granites on the south to the Triassic rocks on the north, but the utmost width of probable ore-bearing rock is 11,500 feet. Thus the territory within which iron ore is likely to be found may be roughly placed at fifteen square miles, (see Plate 11).

The iron ore deposits here, as at Clementsport, are held with the land, hence no royalty is paid upon the mineral. A large part of the district is now owned or controlled by the Annapolis Iron Company. The Londonderry Iron and Mining Company owns some of the remainder of the territory, and controls still more. A few farms have not been included in these operations. The distribution of ownership, both of land and ore, is shown on the accompanying property map, (Plate 12).

Topography and general features.—The district is part of an open farm country, easy of access at all times. The general trend of the topography is north-east in the main part of the field, owing to the line of slope of South mountain and the direction of Torbrook or Black river. This stream, flowing from South mountain northward into the center of the basin, there turns north-east almost to the county line; thence north-west, passing out of the basin to the Annapolis river. The valley is narrow and steep where it emerges from South mountain, but becomes broad and flat in the main part of the basin, so that few outcrops can be found along it.

North-west of this river, where the mines are situated, the land is again higher, although in no part more than 400 feet above the stream. Within half a mile of the latter it begins to decline toward the Annapolis river.

It is upon this very broad, ridge-like eminence that the north line of ore outcrops is situated, in the form of three, or possibly more, beds of iron ore interstratified with the sedimentary rocks of the region.

The southern line of ore, similarly situated with reference to the country rock, is found well up on the side of South mountain and everywhere at considerably greater altitude than the other, within a short distance of the granite which covers a large part of western Nova Scotia. The outcrops and openings are high on the west, declining eastward, because the strike of the deposit is slightly oblique to the trend of the South mountain escarpment, diverging in that direction. In like manner the altitude of the north line of the ore deposit declines eastward, being 365 feet at the Wheelock mine on the west, 131 feet at the Leckie mine on the east, and somewhat lower at the crossing of Torbrook river still farther east. The grades from the South mountain iron ore deposit towards the railroad on the north are rather severe at any point.

Transportation.—Transportation is not a serious problem in this field. For some years a spur line of standard gauge has run from Wilmot station southward 3 miles to the Leckie mine, over an almost level country. Thence it is 1.8 mile south-west to the Wheelock mine, with a rise of 234 feet. In 1906 the standard gauge track was extended to this part of the property, and in 1907 to a newer mine of small size, the Martin, somewhat farther west. As the Leckie mine is not now in operation, all the ore is conveyed from the Wheelock and Martin openings, which are nearly in the centre of the property, to Wilmot station. The district is controlled, and in large part owned, by the Annapolis Iron Company, which delivers the ore to the Londonderry Iron and Mining Company at Londonderry (Acadia Mines), where it is smelted into pig iron.

From the Wheelock mine to Nictaux station on the west is 2.27 miles, down a steep grade. Nevertheless it would not be difficult to connect with the Halifax and South-western railway at that point. This would insure opportunity to ship ore on the Bay of Fundy at Victoria beach by one rail haul, as this road belongs to the same interest as the first-named.

The South Mountain range of iron ore has not yet been opened sufficiently to warrant laying tracks from any present rail line, and greater difficulty would be experienced in grades.

Present transportation to Acadia Mines is unsatisfactory, as the ore has to be hauled over two lines. The Dominion Atlantic railway is used as far as Windsor in any case. From there two routes are possible; in one the ore goes to Truro by the Midland division of the Dominion Atlantic; in the other to Windsor Junction, the Dominion Atlantic and the Intercolonial sharing in this, thence to Truro and Londonderry by the Intercolonial railway. By either route freight charges are an important item.

Water power and wood.—Two streams of some size run through the district—the Nictaux and Torbrook rivers. Neither has natural storage in the form of head water lakes of any importance; and Torbrook (or Black) river has a valley so shaped that at no suitable point could it be dammed without great injury to farming interests.

Nictaux river flows northward throughout the breadth of the district in a narrow valley which broadens when the Triassic rocks to the north are reached. This valley could be dammed at a number of points, forming a succession of storage basins. As it is, there is but one dam, a short distance above the falls at Nictaux.

The horse-power of the stream was taken during an unusually dry time, when the stream had shrunk to small proportions. Assuming the installation of power at the lowest feasible point—where the stream valley widens, north of the village of Nictaux—a head of 122 feet could be secured from the site of the old Nixon dam with 5,800 feet of piping, and a minimum of 133 h.p. without such storage as to increase the minimum volume of water. From the present dam at the falls a head of 77 feet can be secured, and the estimate gives 135 h.p., showing that the increased discharge counteracts the decreased head. This, of course, could be much augmented by proper storage. Previous estimates, made in private reports on the district, range from 250 to 750 h.p.

There is no timber in the district, and none of value for a few miles to the south. But in the heart of the south country is a larger amount of excellent wood, both hard and soft, and of several varieties each, than many mines or electric smelters would require. The timber country is all controlled by one or another of the large lumber companies, with whom negotiations would have to be made.

Adaptability to magnetic surveying.—The iron ores of the district are peculiar in their magnetic property. Normally they are ordinary Clinton ores. But of the two main beds on the north side of the basin—the Leckie and the Shell, which run parallel for at least 13,000 to 15,000 feet—the former is rarely magnetic, the latter always, more strongly so going west. At the western end of the field all the exposures and cuts in various beds show magnetism. On South mountain the exposures of ore are nearly all magnetic.

All the iron beds lie at high angles; thus the magnetic terrain would be narrow, long and extremely regular in shape. The topography, while rather abrupt in one or two places, is on the whole not ill-adapted to the use of the magnetometer.

Two, possibly three, characteristics could be especially well elucidated by this means. In the western part of the district the known continuity of the beds is extremely short. Neither the Shell nor the Leckie bed, as such, can be identified with certainty. Magnetic measurements would establish the length of these veins. At the east, toward the Leckie mine, the Shell bed is lost—or has not been cut in any excavation. Where last met, on the Stanley Brown property, it is still feebly magnetic. Its continuation in this direction could be worked out with ease, as the drift is thin.

The second feature which this method of research should establish is the position and character of faults in the western part of the field, and perhaps also east of the Leckie mine. West of the Wheelock mine, as will be seen by reference to Plates 12 and 17, the ground is more or less faulted, probably clear to the granite of Cleveland mountain. The approximate position of some of these faults is known and their offsets calculated, but of others little has been discovered because of lack of development. Short of actual surface trenching or underground development, the magnetometer is by far the best aid to surveying these breaks. Even an ordinary dip needle was moderately successful in parts of the field.

As will be seen later, knobs of basic intrusive rock crop up at various places on both sides of the basin, and in one or two cases appear to interfere with the continuity of the ore. A magnetometric survey would be of value to settle the question of continuity, if the intrusives are not themselves magnetic, as is the case in some other parts of the province.

From the foregoing it would appear (1) that the Nictaux-Torbrook basin offers an exceptionally good opportunity for the successful employment of magnetometric methods in surveying the ore bodies; (2) that this method would prospect much of the field better and at far less cost than any other which has been attempted; and (3) that the district requires the use of such means in order to bring out its full value—and further, that it is worthy of any reasonable effort to accomplish this end.

Local smelting.—The possibility of a new western smelting centre has been mentioned in Part I, chapter 1. It is here reverted to, in order to show the relations of the different factors in the case.

The problem presents three aspects. According to one, the district as a whole may be regarded as a smelting centre, the coal being brought from a distance. Second, the ore may be shipped to an existing furnace, as Londonderry, Sydney or Sydney Mines. Third, it may be shipped to a new centre of reduction, to which also coal would have to be brought.

(1) There is undoubtedly sufficient ore in the basin to supply a moderate plant for so long a time as to warrant installation if other factors are favorable. In such event all the coal would have to be brought from a considerable distance, as western Nova Scotia south of Cumberland county possesses none. Coal could be had from any Cape Breton district by water shipment to Annapolis Royal, thence by rail to Torbrook or Nictaux, if the works were there. From the Pictou field coal would come by rail from Stellarton or Westville to Pictou Landing, and by water to Annapolis. From the present Cumberland field (Springhill) coal would come by rail to the Cumberland Coal and Railway Company shipping piers at Parrsboro, thence by vessel across Cobequid bay to Annapolis. Instead of using Annapolis as a debarking point, Victoria beach, opposite Digby, might be employed, but this would necessitate a longer rail haul.

Limestone could be brought from near Windsor and from other points in Hants county. That near Windsor is an especially good grade of shell lime of lower Carboniferous age, similar in many ways to that of Red island, Cape Breton, used at present by the Nova Scotia Steel and Coal Company.

The distance from Wilmot, where the spur line leaves the Dominion Atlantic main tracks, to Annapolis is 32 miles; to Victoria beach, 40 miles; and to Windsor, 54 miles. In considering Victoria beach for shipping, it must be noted that the Victoria Beach railway is a part of the Halifax and South-western system. Haulage from Torbrook would have to be over two lines at present, but by making connection at Nictaux station a single line would handle the ore.

In making calculations for large scale operations upon any but the present status, it must not be forgotten that the Clementsport district contains ores of a character sufficiently similar to those of Torbrook to bring its successful exploitation within the range of possibility.

Whether, with all the factors as they are, local smelting will ever be introduced, is impossible to prophesy. Certainly present appearances do not point to it.

(2) According to the present arrangements, the Annapolis Iron Company delivers its ore by rail to the Londonderry Iron and Mining Company at Acadia Mines. The two are closely allied financially, and the latter company owns outright the Leckie mine, lately closed down, and several other parcels of ore-bearing ground. Both companies own both land and ore on some farms, and only the iron ore rights upon others.

The ore is shipped from the property (at present the Wheelock and Martin mines only) to Wilmot, thence *via* main line of Dominion Atlantic and Intercolonial railways to Acadia Mines. This arrangement must be in certain ways unsatisfactory; but because of the present ownership of the ore, in large part perfected since the present study was begun, it is likely to continue for some time.

It would be practicable, at no greater cost, to ship the ore by water from Annapolis or Victoria beach to the Nova Scotia Steel and Coal Company at Sydney Mines or the Dominion Iron and Steel Company at Sydney. In this case the water haul would be approximately 650 miles.

(3) The last possibility is that of a new smelting centre. That the ores of Torbrook and Londonderry well supplement each other is readily seen when it is noted that the former is of good low grade quality, high in phosphorus and in part high in lime, and low in sulphur in most instances; while the latter is especially free from phosphorus and remarkably low in sulphur, but high in lime and magnesia. Moreover, the Londonderry ore is porous, reducing easily during its descent in the furnace, while the Torbrook ore is dense. It would seem, therefore, that any plan looking to the mixing of these ores should receive consideration, and that any scheme for a new western reduction centre should take into account the presence of the Londonderry iron ore range.

Leaving aside the financial problems engendered by present ownership, a smelter erected either at Parrsboro or Annapolis would fulfil the necessary conditions of situation and availability. In the former case the ore from the Torbrook field would be shipped at Annapolis or Victoria beach; and limestone, in part at least, from Windsor on Minas basin—all these being situated on embayments of the Bay of Fundy. The distance from Annapolis by water to Parrsboro is 100 miles; from Victoria beach, 84 miles; from Windsor, 30 miles. The coal would come in part from Springhill by a short haul to Parrsboro, as much does at present; and water shipment from the Pictou and Cape Breton fields would be feasible. Should western Cumberland county be developed as a coal field, fuel from the centre of the basin would come by rail with a much shorter haul than from Springhill; and that from the western rim of the basin would be shipped probably from Shulie, which is capable of being converted into a harbour.

For ore from Londonderry a road would have to be built along the north side of Cobequid bay. As a charter has some time since been granted for such a road, and survey made, its construction may be looked upon as feasible.

In the case of erection at Annapolis such material as would come direct to Parrsboro by land in the first instance could be shipped by water thence to Annapolis.

History of Previous Operations.

Early endeavors.—The existence of iron ore in the basin appears to have been known very early in the nineteenth century, and a small Catalan forge was set up at Nictaux Falls, in which a few tons of bar-iron were made. In 1825, as related in Part II, chapter 1, the Annapolis Iron Mining Company was formed, erecting a large smelter on Moose river, in the village of Clementsport. Part of the ore there treated came from the western part of the Nictaux-Torbrook field, near Nictaux river. Later a charcoal smelter was erected at Nictaux, and the veins of ore explored with some thoroughness. Slag from this furnace may even to-day be found in great abundance in the river bed.

In 1855 an English company mined a shell magnetite in the western part of the field, spoken of locally as the Shell bed, but never demonstrated to be the same as the long Shell bed to the east. At least two openings were used—one close to the furnace at Nictaux Falls, the other about two miles east. Limestone for flux was brought from St. John to Port George, on the Bay of Fundy, ten or eleven miles from the furnace, whence also the pig was shipped. The works closed down about 1860, because of too great cost of production.

Page and Stearns.—In 1870 Page and Stearns started to make rail connection between Middleton and Bridgewater, on the south shore of the province. In connection with the promotion of this scheme they opened ore pits at many places west of Nictaux river and as far west as Lawrencetown, six miles from Nictaux, all in magnetite. Some property was acquired, still known as the Stearns property of Cleveland mountain and the Page and Stearns property of Torbrook. Much more of the country was taken under lease, with the intention of development when their railway, the Nictaux and Atlantic, was completed. The scheme came to nothing, however. The railway was later completed as the Nova Scotia Central, and recently taken over as part of the Halifax and Southwestern system.

In all this early work the Leckie vein appears not to have been touched, all interest centering upon the Shell bed and various magnetic fossiliferous beds to the west. In these were made open cut trenches, often of considerable length, especially on the Shell bed from the Fletcher Wheelock farm west. No underground mining was attempted.

Leckie mine.—In 1890 Major R. G. E. Leckie, then manager of the Londonderry Iron Company, took royalty options upon certain iron ore deposits in the eastern part of the district, where since has been located the Leckie mine; and in 1891 operations were started. This mine is described separately later. In 1896 the property became idle, because of closing down at Londonderry and an absence of any other market for the ore. Previously the Leckie ore had gone in part to Londonderry, part to Ferrona.

In 1903 the mine was reopened by the Londonderry Iron and Mining Company, coincidently with the reorganization of the Acadia mines, running until the summer of 1906, when it became exhausted and was shut down. Evidence will be offered later indicating that, while all the ore obtainable from the old shafts has been extracted, the same horizon may carry more lower down.

Annapolis Iron Company.—The Torbrook district has been identified with Londonderry since 1890. Recently the Londonderry interests obtained an option upon a large part of the district; and besides widespread surface prospecting and sinking of numerous boreholes, developed the beginning of a mine on the Shell bed, on the Fletcher Wheelock property and close to the Torbrook-Nictaux road. During the winter of 1906–07 these options were closed, a new company, called the Annapolis Iron Company, being formed to operate. Much the same financial interests are concerned as in the Londonderry company. Very recently underground development has commenced in the Leckie vein on the Martin property, west of the Wheelock mine, with the purpose of making a new mine there. The work was begun so late that details cannot be given in this volume, beyond a few analyses later.

Output.—The beginning of the arrangement to take ore from Torbrook (Leckie mine) to Londonderry dates back to 1889, and in 1890 a shipment is recorded of 1,365 tons; in 1891, 7,273 tons; 1892, 27,114; 1893, 29,839, of which 20,000 went to Londonderry, the remainder to Ferrona; 1894, 21,664, divided between the two furnaces; 1895, 29,940; 1896, 19,944 up to July, when the Leckie mine closed down. It reopened in April, 1903, and in the remainder of the year nearly 5,000 tons were mined. For 1904 no public record was made of the output; in 1905 it was 14,538 tons; in 1906, 27,000.

For the very early years, during the life of Nictaux furnace, no adequate records exist.

General Lithology.

Series represented.—The western part of Nova Scotia, south of the Bay of Fundy, is largely underlain by the pre-Cambrian gold-bearing (Meguma) series and its associated igneous rocks. The latter include chiefly granites, of which the main body is a great massif occupying many hundred square miles and forming the northern margin of the main plateau of the province, to a height of 600 to 700 feet. To the north of the granite the sedimentary rocks are topographically much lower, and the escarpment thus formed is called South mountain.

Running along the face and base of this escarpment, intermittently from near Weymouth on the west to the Nictaux river, thence without interruption nearly to the Avon river on the east, are various types of sediments, ranging from the upper group of the pre-Cambrian gold-bearing series (Halifax formation) to the Devonian. In part these form a portion of the highland, or hilly country hardly lower in altitude; in part they are so low as to grade into the flat Triassic topography to the north. All are invaded by the granites or their basic marginal equivalents, which to some extent assume the form of diorites.

Inglesville district.—Of these sedimentary areas, the only ones of interest in this connection are (1) the Inglesville district and (2) the Nictaux-Torbrook basin. The first is bounded on the north by the Triassic sediments of the Annapolis valley and on the south by the main granite mass; on the west lies part of the main granite, which south of Lawrencetown reaches northward to the Triassic. On the east, at Inglesville, a broad tongue reaches from the main mass of the granite up to the Triassic and cuts this iron area off from the Nictaux district, of which it is a logical extension.

Its rocks are in general similar to those of the eastern basin, and it contains a certain but quite unknown amount of bedded magnetic iron ore. But the country is little prospected, and natural outcrops are few. Nothing in detail is known of its structure, or of most of its iron; and discussion of the district is not to be attempted at this time.

Eastern areas.—From the east side of the granite tongue above mentioned sediments stretch without complete interruption for many miles, to the Carboniferous of the Minas basin. The detailed geology of this part of the country is at present being worked out by the Geological Survey, and in this connection it is sufficient to say that the studies to date show a succession of rock series occupying areas which are much elongated parallel with the margin of the granite plateau to the south. It is unnecessary to enumerate these areas, the rocks of which appear to be conformable throughout a single unit, but, in some instances at least, unconformable with those of adjacent areas. Some are regarded as of the same age as those of the

Torbrook basin; but thus far no iron ore deposit of importance has been discovered in them, the only reported occurrence not having been verified.

The limits of the Nictaux-Torbrook basin have already been noted. It appears to include two of the series represented to the east, according to the present views of the Geological Survey. Of these the upper, of Silurian age, contains the iron ore. Paleontological evidence as to age is abundant, and in published references hitherto part at least of the strata have been called lower Devonian. The usage here adopted is that of the field party of the Geological Survey working upon the rocks at present.

Sediments of the basin.—The stratified rocks of the district include coarse and fine sandstones, and their altered equivalents as quartzites; gray, green, bluish and red shales, and their metamorphic forms possessing a slaty cleavage; and limestones. The last are, in certain instances, ferruginous, passing into hematite and magnetite.

The south side of the basin is everywhere occupied by dark green, gray and black slates. In the eastern portion, the centre and the area north of it present fawn, green, black and gray shales, and many bands of quartzites of various colours. These are all shown well in traverses along Saunders, Messenger, Burns and Spinney brooks, and in the lower and eastern portion of Black or Torbrook river.

At the extreme west, a complete traverse of the basin can be had upon Nictaux river; and a section of the southern half upon Torbrook river, approximately three-quarters of the distance toward the western end of the district. In both these only the gray and black rocks appear, none of the fawn, light green or very light gray coming to the surface.

The quartzites have some importance in any attempt to work out structure; as one apparently characteristic bed is found at known distances north of the zone of iron ore on the north side of the basin, and a similar bed is found in places south of the South mountain iron ore deposits. The quartzites in the centre of the basin at the east end are in many instances repetitions; but whether any of them are the same as the two associated with the iron ore, as has been thought by some observers, remains to be proved. Very coarse sediments are not known in the rocks of this basin.

Eruptives.—The general distribution of the granite has already been mentioned. Toward the margin, in places the rock becomes darker and finer, turning to diorite; but this is by no means without exception. In addition to the main mass of intrusives there are many isolated bodies of dark and more or less basic igneous rocks, of medium to fine grain. The number and distribution of these are not known. Many more are present, however, than are represented in the preliminary map of Torbrook issued in the Summary Report of the Geological Survey for 1904.

Their chief importance in relation to the iron ore deposits consists, first, in the influence which they may have upon the distribution of the latter, second, in the metamorphic effect of the intrusives as a whole upon the hematite. This subject is dealt with elsewhere. As to the former, it may be said that in at least one place, west of the Leckie mine, an apparent absence of the ore along a line in which it should be found seems best explained as the effect of the presence of a boss of intrusive rock immediately to the north. On the other hand, to the west on the properties of M. Hoffman, Page and Stearns, and Josephine Wheelock, the Shell vein, 80 feet south of the Leckie, is not affected. But the Leckie is thin throughout this distance and as far west as beyond the Wheelock mine, becoming good once more on the Edward Martin property. While the western part of this lean portion of the Leckie is quite far from any boss, it is possible that the depauperization is the effect of the presence of two intrusive masses north of the ore. Another on the J. Allen property, west of Martin's, may have the same effect; but whether this be true is not known certainly, because of the absence of development work.

Metamorphism.—Metamorphism of both dynamic and contact types is shown in most of the field. In the north-eastern portion the red rocks, and to a certain extent others, lack slaty cleavage; even here, however, the light colored sandstones have altered to dense quartzites. The southern part of the field has everywhere slaty cleavage in the finer rocks; and this is true wherever in the basin the gray sediments are found without the red strata. In part this is the result of dynamic changes.

However, on the south side of the basin there is a progressive increase in metamorphic effect westward, and inspection of the map shows that there the granite to the south approaches nearer. The western end of the district is all much more altered than the eastern, the slates being harder and the coarser rocks more massive. This appears to be due to increasing proximity of the granite tongue behind Cleveland mountain.

Ore beds.—The iron ores of the basin are all of the Clinton type, interbedded with the strata, and all originally hematites. In the east this is still true, both of those on the north side of the basin and of those on the south. Westward all the southern ore deposits and a part of the northern become magnetic; and west of the Bloomington road, between Black and Nictaux rivers, there are no openings upon non-magnetic ore. This appears to indicate that the change from Fe_2O_3 to Fe_3O_4 is a metamorphic effect depending upon the action of the granites.

This has another bearing. The age of the granites can be shown to be early Devonian. In exerting a metamorphic action upon the iron ore, they stamp the latter as of earlier age. The fact that in the ground west of the Leckie mine the eruptives apparently have prevented the deposition of the iron ore, can be explained when the mine is described. It will there be seen that the beds may have been so squeezed as to bring together the wall-rocks, shutting out the ore stratum.

Clinton ores should possess great continuity on the strike; and in the Torbrook district two beds on the north side and one on the south can be traced for a long distance. Of the former, the Leckie can be identified for 15,000 feet, the Shell bed for 13,300 feet, with a probable extension westward. The South Mountain vein can be identified with moderate probability for 10,000 feet, and with fair possibility of its extension to 19,000 feet.

Little is known of the depth, except in the Leckie mine and in one or two of the calyx drill holes. The former lost the iron ore at 330 feet in the Woodbury shaft, not because of lack of concentration, but from pinching of the walls. This is 200 feet below sea level. The Fletcher Wheelock borehole left the Lean Hematite vein, north of the Leckie, at 382 feet, or slightly below sea level.

The difficulty in tracing the Shell vein westward is due largely to the fact that in this direction there is much repetition of shell ore beds across the strike—a condition which may indicate either a number of separate ore horizons or folding. Further detail regarding the ores is given in describing the openings and mines.

Structure.

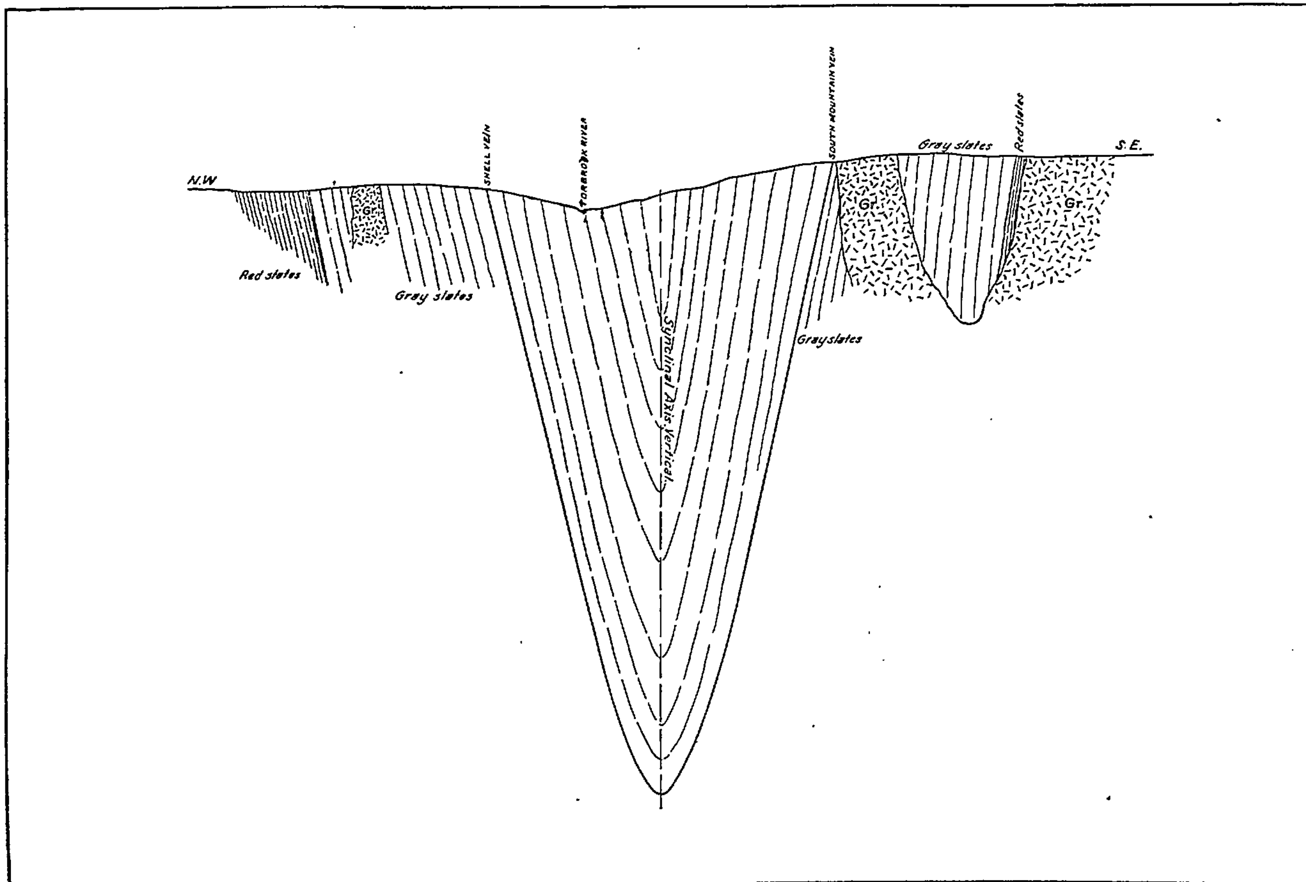
The structure of the basin is of especial importance; because here, more perhaps than elsewhere in the province, should a knowledge of this feature aid in mining development. It is to be regretted that, with all the work put upon the field by various students, there still remain several essential points to be established.

Previous studies: simple folding.—It is unnecessary to expand here upon the stages by which present knowledge of the district has been reached. It is sufficient to say that up to 1905 no serious expression of opinion upon the structure had been made, other than that it is a single large syncline. This appeared obvious as in the north there are certain stratified deposits of hematite and magnetite dipping steeply south-east; and on the south are other beds, possibly identical with the first, dipping steeply north-west. From the first, it seems to have been assumed that the northern and southern beds were the same, and that the apparent structure indicated a single large syncline (see Plate 13).

The relation of the red beds in the east to the gray beds was not inquired into; although the presence of the former has long been known, because Messenger, Spinney and the other brooks near the county line have been justly celebrated as fossil localities. It is noticeable that, with all the collecting that has been done along these brooks, the rocks have never been divided into paleontological stages, which might perhaps prove a key to a structure most difficult to work out by lithological means.

Recent studies: multiple folding.—In 1905 appeared a preliminary description of the basin by Mr. Hugh Fletcher (Sum. Rep. Geol. Surv. Can. for 1904), and a reconnaissance geological map, which was of especial advantage in that it appeared at a time when large financial interests were about to become involved in the district. Both the map and the description of openings, of which by that year there were many, were the first published. It is somewhat unfortunate, however, that some of the descriptions of ore belts, where acquired from statements of other parties rather than from observation, cannot be verified.

PLATE 13.



Diagrammatic cross-section of Nictaux-Torbrook basin, on theory of simple synclinal folding.

Mr. Fletcher's field work in 1905, in the same district, led him to state (Sum. Rep. Geol. Surv. Can. for 1905, p. 120) "The work seems to prove that the rocks lie in several synclines." That the evidence then available constitutes proof is perhaps too strong an assertion, but it might be said that it indicates strong probability of some form of this type of structure.

Even with the evidence gathered during the field season of 1906, it would be hazardous to state dogmatically that multiple folding has been proved; although borings show the certainty of one subordinate fold south-east of the Leckie mine.

Hypothesis of pitching synclinorium.—What the structure traverses of the district and the lithological distribution of the rocks would appear to the present author to indicate are:—

(1) That the region is one of complex folding, being a part basin.

(2) That the longitudinal section along the strike of the axes of folds, approximately N.40° E. (magnetic), shows a pitching of the composite fold as a whole south-westward, the angle of pitch being 10° or less. There is, so far as known, no north-eastward pitch at the south-west end of the field, so that the basin structure is incomplete.

(3) That the red rocks in the north-east, north and north-west underlie the gray as a whole, coming to the surface in these portions, but not outcropping in other parts of the field because hidden by the overlying gray rocks.

(4) That the productive iron ore deposits, although not exclusively confined to the gray rocks, are characteristic of them, and are therefore more abundant toward the south-west.

(5) That transverse sections of the basin exhibit several anticlines and synclines, of which the exact number and the situations of the axes are, however, not completely determined.

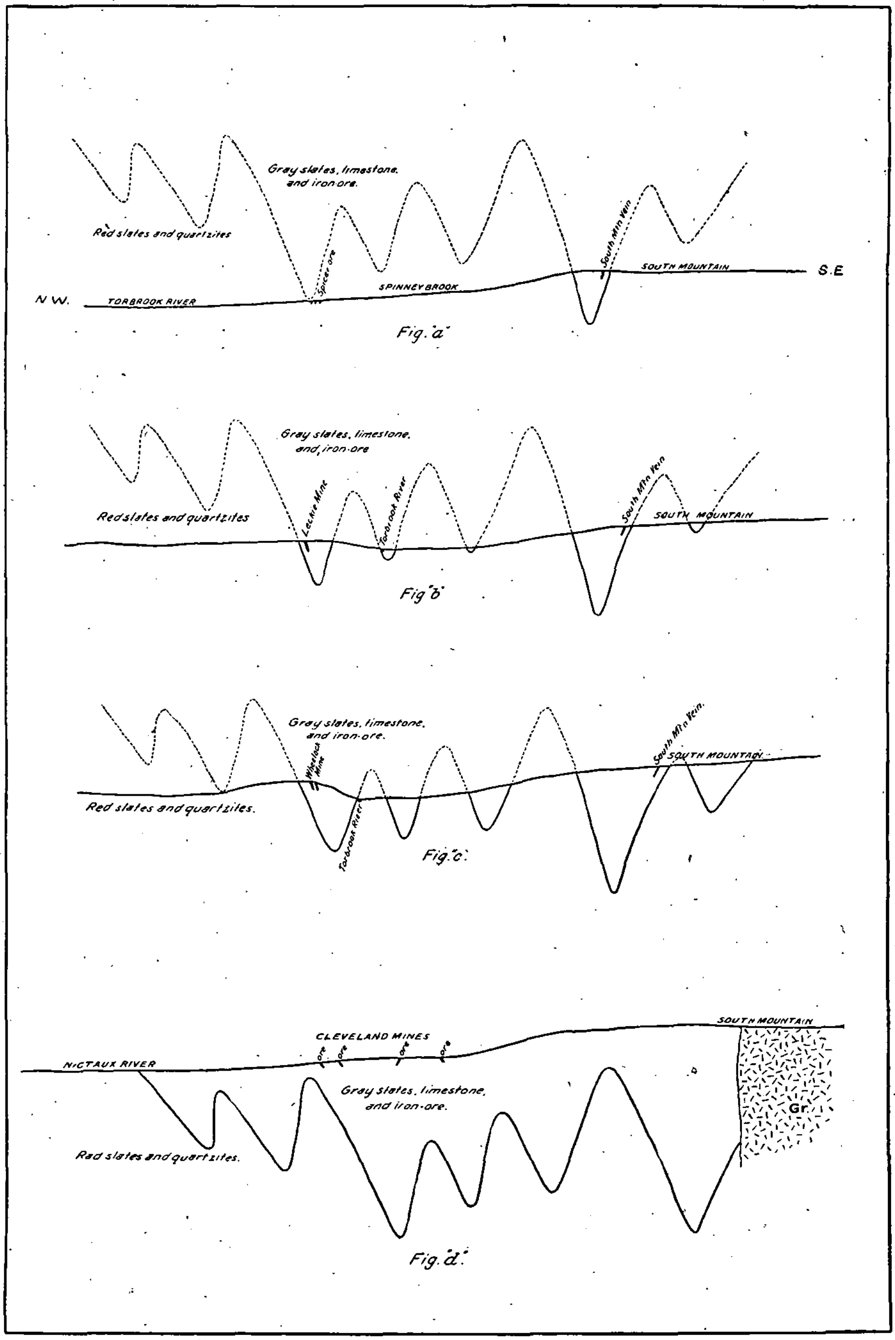
(6) That, contrary to expectation, the dominant type of fold in this cross-section is the *anticline* in the center of the basin, the synclines being shallower; while on the north-west margin the same condition obtains, and on the south-east margin the synclines are dominant, (see Plate 19).

This means that in the eastern portion of the district the red rocks reach the surface everywhere except on the south-eastern side. In the middle of the field the central rocks are covered by drift; but while the strata on the south-eastern margin are exclusively gray, and also near the outcrops of the iron ore on the north-west, beyond the latter and adjacent to the Triassic the red rocks once more appear. In the western half of the basin no red rocks appear in the longest traverses.

(7) That it cannot be determined with certainty whether the South mountain ore beds are equivalents of the Leckie, Shell and Lean Hematite beds on the opposite side of the basin. Certain indications, however, point to this condition, especially their relation to a certain quartzite in both situations.

(8) That the frequency of iron ore occurrences in the western half of the field, in any traverse of the basin, may be due either to duplication of

PLATE 14.



Diagrammatic section across centre of Nictaux-Torbrook basin, to illustrate possible synclinorium structure.

the three known beds by nearly isoclinal folding, or to the presence of a considerable number of ore-bearing strata which have separate origin. The former is as likely as the latter.

Some diagrammatic cross-sections of the basin, upon the hypothesis advanced above, are appended (Plates 13, 14). They are not to be regarded as having any quantitative value, since all the factors—pitch, number, location and altitude of the subordinate folds—are still more or less in doubt; but they will serve to illustrate the principle

Consequences of hypothesis.—The earlier ideas of structure involved a very deep fold in the ore-bearing rocks, allowing and requiring ultimately deep mining, should the iron ore carry throughout. The work of a few years ago assumed a number of small co-ordinate folds, so that the iron ore should be found repeated several times across the basin, possibly increasing the amount speculatively available and certainly decreasing its depth. It did not, however, account for the lack of ore in the centre of the basin at the east end and its prevalence near Nictaux river.

If the hypothesis advanced above be correct, it will account for the characteristic just mentioned; will indicate the improbability of iron ore in the centre in workable quantities until nearly as far west as where Torbrook river traverses this portion of the field; and will point to the probability of a number of ore occurrences in synclinal folds west of this stream at various points transversely across the basin. Whether these are duplications or successively new occurrences, and whether they, the South mountain and the Leckie, Shell and Lean Hematite beds on the north-west can all be correlated, evidence is not yet sufficient to prove.

Other details regarding structure will be given in connection with the descriptions of openings and mines.

Catalogue of Iron Occurrences.

Properties showing iron ore.—On the south-east side of the basin, from east to west, the following properties have iron ore exposed upon them:—

1. T. B. Messenger.
2. Amos Burns.
3. W. O. Baker.
4. J. Uhlman.
5. J. Foster.
6. John Foster estate.
7. Whitfield Wheelock.
8. Stanley Brown.
9. J. L. Brown.
10. I. J. Whitman.
11. Obadiah Brown.
12. James Jefferson.
13. E. and M. Baker.
14. Samuel McConnell.

15. Fletcher Wheelock.
16. H. L. Wheelock and J. Goucher.
17. M. and E. Armstrong (two farms).
18. D. B. Armstrong.
19. M. Hoffman and G. Vidito.

On the north-west side, from east to west, are the following:—

20. Mrs. Spicer.
21. David Banks.
22. Peleg Spinney.
23. Peleg Eaton.
24. Nelson Hart.
25. Robert Neily.
26. E. M. Barteaux.
27. Londonderry Iron and Mining Co., Ltd.
28. S. Barteaux.
29. Barss and Burns.
30. Archibald Banks.
31. Stanley Brown.
32. George Holland.
33. M. Hoffman.
34. Page and Stearns.
35. Josephine Wheelock (Albert Wheelock estate).
36. DeLacy Foster.
37. Maynard Wheelock.
38. Arthur Wheelock.
39. Fletcher Wheelock.
40. Geo. Banks estate.
41. H. L. Wheelock.
42. J. Goucher.
43. Edward Martin.
44. J. Allen.
45. George Conant.
46. William Ward.

Scattered openings in the vicinity of Nictaux river are:—

47. J. B. Foster.
48. Nelson Vidito estate.

West of Nictaux river, in the Cleveland mountain district, are:—

49. Stearns.
50. John Heatley.

North-westward, close to the granite tongue which separates this basin from that of Inglesville, are:—

51. J. H. Parker.
52. C. F. Armstrong.

Where, as is often the case, the openings are arranged in linear series and are evidently upon the same veins, farms which are not represented in the above list probably also are underlain by ore.

South Mountain Pits.

Messenger vein: pit No. 1.—On the property of T. B. Messenger, between Burns and Messenger brooks, are three openings, apparently upon the same ore bed, which may be called the Messenger vein. The two eastern pits show but little, either in rock section or ore. All bearings and courses given below are magnetic, the declination being 20° W.

No. 1 pit gives no section, being caved in. The small amount of ore on the surface, about 200 lbs., is dark, oölitic, siliceous hematite mixed with much ferruginous sandstone. Sample 163 is a general test of this small dump.

	No. 163
Fe.	39.21

Pit No. 2.—S. 57° W. 203 feet is the middle opening (No. 2 Pit), which shows the rock but does not give a good section of the ore. The strike and dip here appear to be N. 46° to 47° E., 86° N. W. The ore is similar to that in No. 1 pit. Sample 162 is a general one of 500 lbs. of loose ore.

	No. 162
Fe.	43.87

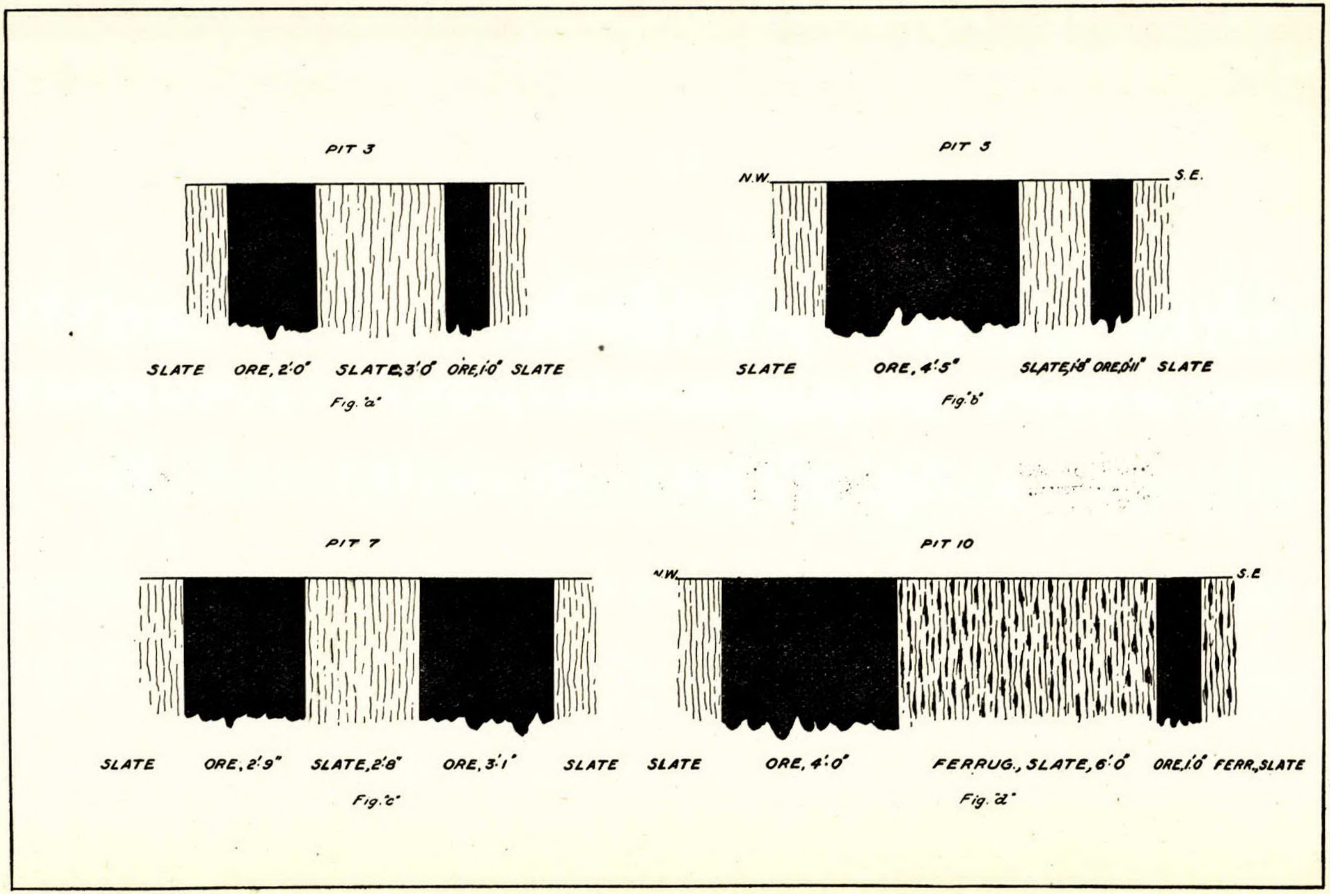
Messenger Pit (*No.* 3).—S. 52° W. 120 feet is the Messenger pit. Like the others it is in the woods, half-way up the side of South mountain. The opening is a timbered shaft, full of water, and its underground characteristics are not known. A section given by Fletcher (Sum. Rep. G. S. C. for 1904, p. 313), apparently not from personal observation, is—

Ore.	2 feet	
Slate.	3 "	
Ore.	1 foot	total 6 feet.

On which side the band lies is not stated. In the preliminary map accompanying, the depth of the shaft is given as 215 feet.

The ore is a fair appearing hematite, somewhat slaty and with a marked oölitic structure.

PLATE 15.



Sections of ore in pits, South Mountain.

A number of analyses are extant from this property, all of which may perhaps have come from the big pit. The labels, however, are in some cases confusing, as will be seen below.

No. 34 (Mines Branch) is a general sample from 100 tons.
T-1 Compact red siliceous ore; L. I. and M. Co.
T-2 Messenger farm; W. F. Jennison.
T-3 Messenger No. 1; north vein; Carlson samples; W. F. J.
T-4 Sample A; Messenger pit; W. F. J.
T-5 No. 2 pit, Messenger farm; Carlson samples; W. F. J.
T-6 Messenger mine; W.F. J.

	No. 34	T–1	T–2	T–3	T–4	T–5	T–6
Fe. . .	36.81	32.24	32.28	32.60	33.730	34.20	60.800
SiO_2 .	....	....	38.06	33.47	37.350	....	5.790
Insol.	....	40.11	39.86	....	....	....	....
P. . . .	....	....	1.37	....	.983	....	.370
S. . . .	....	....	trace	....	....	....	.091

Although the bed has been reported 2,200 feet south-west, on the property of Amos Burns, no data could be secured regarding its occurrence.

Status of Messenger ore.—It is noticeable that the Messenger ore is north-west of the range of the other openings on that side of the basin (or is offset down the dip); and it will be seen that it is somewhat different in character. It is practically without fossils, is oölitic and non-magnetic, and in many ways resembles certain ore uncovered in the country east of the Leckie mine, in and near Torbrook river. There is a further resemblance in the fact that both above and below it are the light green and fawn-coloured slates which mark the lower part of the series at Torbrook.

This would indicate that the iron ore occupies a lower, and on the whole more unfavourable horizon than that of the South mountain and other beds to the west, despite the fact that its outcrop is offset toward the centre of the basin as a whole.

Another possible interpretation would correlate the Messenger and South mountain ores, explaining the discontinuity on the strike by a left-handed twist or a fault. Both these conditions exist in different parts of the field. This seems, however, less probable than the other hypothesis.

Pit No. 4.—West of the Spinney Brook road, on the farms of W. O. Baker and of John Foster, openings are reported but could not be found. Upon the property of J. Uhlman, between the two just mentioned and close to the Canaan Mountain road, is an untimbered pit full of water. A small amount of ore, about a ton, is on the surface, from which sample 8 was selected of the best obtainable. The ore is hard, black, somewhat lustrous, and evidently highly siliceous. In appearance it grades into a ferruginous black to gray quartzite.

	No. 8
Fe.	31.90

South Mountain vein: pits 5 to 14.—That the ore just described is part of the South Mountain vein is not certain, but is probable. The pit is slightly north of its proper range, but the ore is similar to that to the west, and entirely different from the Messenger ore. Pit No. 5, on the farm of Whitfield Wheelock, is the easternmost of a series which appear to represent a single vein, called locally the South Mountain vein. It is a timbered shaft and has near it a 20 ton dump, largely slate. The ore is a highly siliceous black magnetite. A few fossils, *Spirifers*, were seen, but they are rare. The dump shows some light green slate, similar in many ways to that marking the walls of the Leckie vein.

The following is a transverse section of the belt from south to north:—

Ore	0′–11″	
Slate	1′–8 ″	
Ore	4′–5 ″	total 7′–0″

The non-magnetic quality of the Messenger ore is in part associated with its individuality as a separate vein; but in part it may also be due to its distance from the granite mass to the south. Immediately south of Pit No. 5 the contact swings to within 3,600 feet, and thence westward it remains near the line of openings. While the ore on Uhlman's farm is somewhat magnetic, that in all the pits westward is strongly so.

There are several analyses available for this ore, and they vary widely. The Mines Branch sample was selected from a very small dump (No. 9).

T-7 W. F. Jennison;

T-8 No source recorded;

T-9 Ditto;

T-10 Hall shaft magnetite; W. Wheelock property, taken from the thicker ore band; Londonderry Iron and Mining Co.

T-11 Hall shaft magnetite; source unknown.

T-12 Ditto; "11 inch seam, south side;" the narrower of the two ore bands; L. I. and M. Co.

	No. 9	T–7	T–8	T–9	T–10	T–11	T–12
Fe.	46.210	51.410	53.630	56.720	36.28	46.84	20.89
SiO_2.	19.330	12.980	....	10.400	....	....	....
Insol.	....	13.720	....	....	....	....	....
Al_2O_3	5.220	....	....	3.900	....	....	....
CaO.	3.080	....	....	2.000	....	....	....
MgO.	.500	....	....	none.	....	....	....
P.	1.160	.930	.115	.434	....	....	....
S.	.004	.022	.397	.024	....	....	....

Pit No. 6, on the property of Stanley Brown, is a small and old opening partly filled in. About 100 lbs. of highly siliceous magnetite are on the surface, from which sample 10 was selected. One other analysis is available. (W. F. J.)

	No. 10	T–13
Fe	46.210	27.870
SiO_2	20.930	....
Al_2O_3	4.330	....
CaO	2.200	....
MgO	.370	....
P	1.090	....
S	.004	....

On the adjoining farm west, that of J. L. Brown, is a small filled-in pit (No. 7) and a hollow where another pit may perhaps have been. Three iron ore veins are reported, from north to south, giving ore 2 feet 9 inches, 3 feet, and 31 feet 1 inch. None of these could be in any way verified, and no trace of the gigantic band represented on the map of 1905 could be found. On p. 313 of the Summary Report for 1904, a section for some pit on this property is given as follows: which belt is meant, is not indicated.

Ore	2′–9″	
Slate	2′–8″	
Ore	3′–1″	total 8′–6″

The ore from the small opening referred to, representing the northern of those reported, is a very siliceous magnetite. Sample 11 was selected from several hundred pounds of clean ore. No. T-14 is labelled "hard magnetite," and is from L. I. and M. Co.

	No. 11	T–14
Fe	34.92	27.07

On the narrow farm of I. J. Whitman, near the eastern line-fence, is pit No. 8; an old untimbered hole filled in with boulders. A dump of 100 lbs. of siliceous glistening magnetite is all that is to be seen. Sample 12 was selected from this.

	No. 12
Fe	35.83

Pit No. 9 is in the middle of Obadiah Brown's farm, the rocks being opened by a trench 15 feet across the strike. The ore is a dark siliceous magnetite, varying much in the apparent amount of silica. No section of the trench could be made, but the ore is reported to be 9 feet clear. Sample 13 was selected from a ton of the best ore. T-15 is from L. I. and M. Co.; T-16 is by W. F. Jennison.

	No. 13	T-15	T-16
Fe	43.40	46.64	30.880
SiO_2	....	....	33.160
P	....	....	1.738
S	....	....	....

Ore is reported as opened on the farm of James Jefferson, but was not found.

Pit No. 10 is at the eastern side of the property of E. and M. Baker, and is locally spoken of as Baker No. 1. The opening is a timbered shaft 12 by 14 feet. The following elaborate section is given by Fletcher (loc. cit.):—

Ore	0′–10″	
Slate	2′–10″	
Ore	4′– 0″	
Slate	2′– 6″	
Ore	0′– 7″	
Slate	1′– 6″	
Ore	2′– 3″	
Slate	3′– 3″	
Ore	0′– 6″	total 18′–3″

My own section, for which the pit was unwatered, was much less composite as follows:—

Ore	4′–0″	
Ferruginous slate	6′–0″	
Ore	1′–0″	total 11′–0″

South wall ferruginous slate.

The belt is practically vertical. The ore is very dark and heavy, somewhat less siliceous than that of pits north-east. It may be noted that the granite is at a greater distance here. The 6 foot slate band is dark and can be distinguished from the ore only by its cleavage. It is so ferruginous that an analysis would run up almost to a low grade iron ore. The slate on the south wall is similar to the band.

A dump of a ton weight lies on the surface, from the least siliceous parts of which sample 14 was selected. No. 150 is a general section of the 4-foot ore belt. T-17 is recorded in several publications, the analysis being by Geol. Surv. Can.

	No. 14	No. 150	T-17
Fe	48.030	45.82	53.61
SiO_2	19.110	22.16	....
Insol.	....	....	12.89
Al_2O_3	6.200	4.93	....
CaO	2.950	4.15	....
MgO	.380	.42	....
P	1.320	1.44	....
S	.005	.01	....

Pit No. 11 is on the east side of the property of Samuel McConnell, and is locally known as McConnell No. 1. The opening is a dry timbered pit, 12 by 5 feet and 10 deep. The ore is very black, dull in lustre and siliceous.

The section measured is:—

North wall, slate.

Ore	5′- 6″	(in places 5′-0″)
Slate	1′- 1″	
Ore	0′- 4″	
Slate	1′- 4″	
Ore	1′- 0″	
Slate	1′- 0″	
Ore	1′- 0″	
Slate	0′- 4″	
Ore	0′-10″	total 12′-5″

South wall, slate.

Much of the slate is very ferruginous. The section given by Fletcher (loc. cit.) is as follows:—

Ore	0′- 8″	
Slate	2′- 6″	
Ore	5′- 0″	
Slate	2′- 6″	
Ore	1′- 2″	
Slate	1′- 5″	
Ore	1′-10″	
Slate	3′- 0″	
Ore	3′- 4″	total 18′-5″

Sample 15 was selected from a 2-ton dump. No. 148 is a selected sample of the main belt.

	No. 15	No. 148
Fe	54.530	36.41
SiO_2	12.680	....
Al_2O_3	2.500	....
CaO	.950	....
MgO	.430	....
P	1.000	....
S	.003	....

Adjacent to this pit and to the next is a calyx drill hole, which will be described with other surface drill holes.

Pit No. 12 is the western pit on the same property, known as McConnell No. 3. The cut is a trench 18 feet across the strike and 3 feet deep.

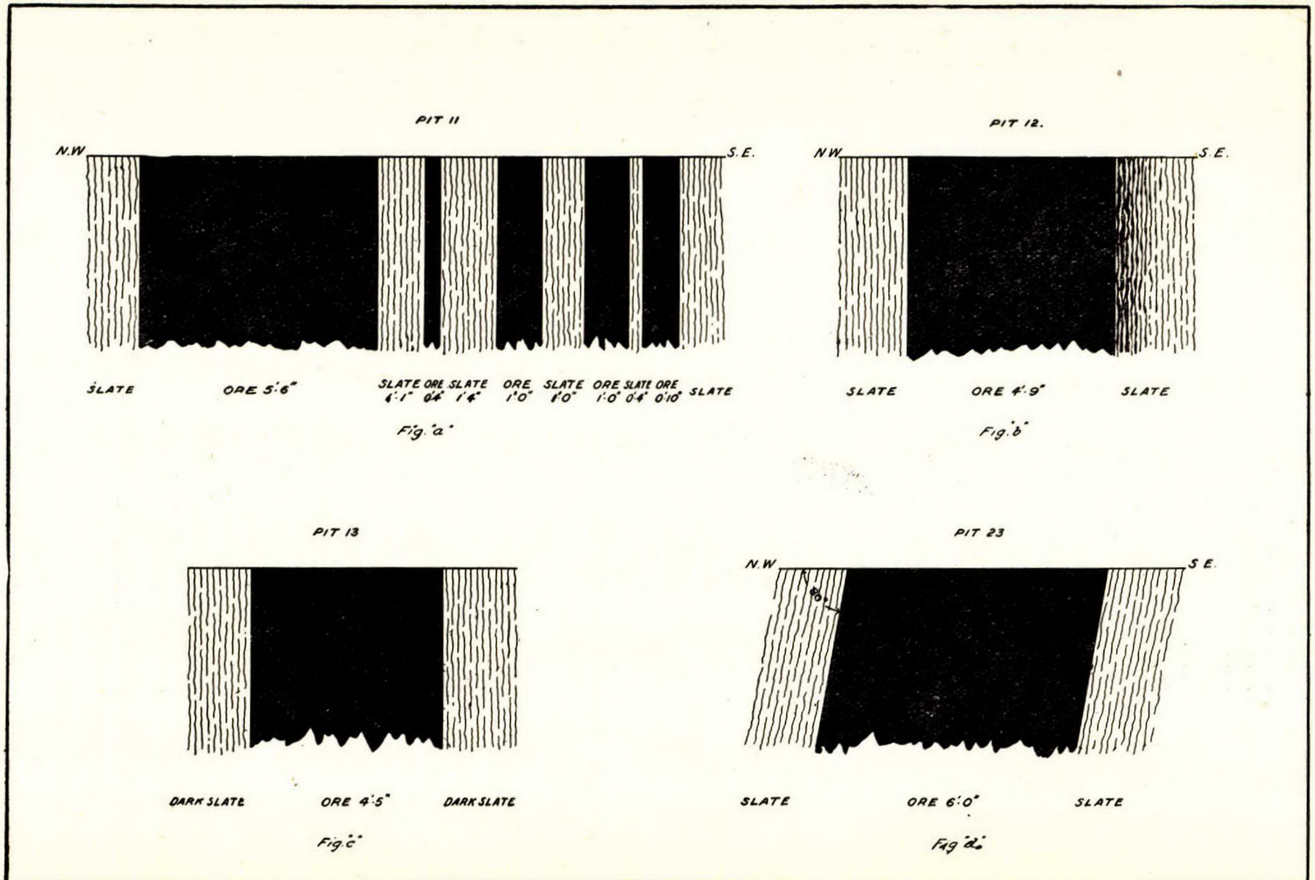
The section gave:—

North wall, slate.

Ore	4′-9″

South wall, highly ferruginous slate.

PLATE 16.



Section of ore in pits, South and Cleveland Mountains.

This was all that seemed worthy to be called ore. Fletcher's section (loc. cit.) is as follows:—

Ore	1′- 2″	
Slate	2′-10″	
Ore	4′-10″	
Slate	2′- 9″	
Ore	1′- 0″	
Slate	1′- 6″	
Ore	1′- 7″	
Slate	3′- 0″	
Ore	0′- 2″	total 18′-10″

The ore is like that in other pits near—dark, siliceous and magnetic. It is of the best grade in the centre of the belt. Sample 16 was selected from 3 tons of dump; 149 is a general sample of the 4 foot belt. Two analyses from other sources belong here, and probably a third. T-18 is by Geol. Surv. Can., marked "McConnell No. 2"; T-19 is by W. F. J.; T-20 is by the same, but has no pit number.

	No. 16	No. 149	T-18	T-19	T-20
Fe	36.41	34.73	55.45	34.720	54.870
SiO_2					9.900
Insol			13.03	20.490	
P				3.192	.750
S					.099

Pit No. 13 is in a corner of the E. and M. Baker farm, across which the ore belt runs very obliquely, and is called Baker No. 2. It is a cribbed shaft, full of water. The ore is 4 feet 5 inches wide, with dark slate walls. The adjacent rock was not regarded as ore, although very ferruginous. Fletcher's section for this (loc. cit.) is:—

Ore	1′- 0″	
Slate	2′- 0″	
Ore	5′- 0″	
Slate	3′- 3″	
Ore	1′- 7″	
Slate	1′- 4″	
Ore	1′- 1″	
Slate	0′- 3″	
Ore	0′- 5″	
Slate	2′- 6″	
Ore	0′- 8″	total 19′-1″

The ore here is apparently of much better quality than farther east, being less siliceous and heavier, and is altogether the best looking magnetite on the range. Sample 36 is a general test of a small dump; 151 is a general sample of the main belt.

	No. 36	No. 151
Fe	47.090	49.510
SiO_2	20.200	19.560
Al_2O_3	3.700	5.460
CaO	4.550	2.150
MgO	.450	.900
P	1.390	.745
S	.051	.009

Pit No. 14 was at one time recorded on the western side of the McConnell property and called McConnell No. 4. It was not possible to get any first-hand knowledge of it, but Fletcher's section and an analysis follow:—

Ore	1′– 8″	
Slate	2′– 8″	
Ore	4′– 0″	
Slate	3′– 6″	
Ore	1′– 0″	
Slate	1′– 3″	
Ore	1′– 6″	
Slate	3′– 9″	
Ore	0′– 4″	total 19′–8″

Analysis T–21, Geol. Surv., Can.:

	T–21
Fe	55.69
Insol	15.48
TiO_2	none

In the McConnell and Baker sections the ore from the central main band sometimes has a brownish streak, which, with the decreasing silica, suggests a lower degree of metamorphism than to the eastward. It would appear to be a direct result of the recession of the granite, which here is a mile to the south-east.

Some of the ore shows fossil shells, as does that on the Baker property, but most is massive and barren.

Pit No. 15 is at the crossing of Torbrook river by the South mountain bed, and shows nothing at present. Fletcher states that the ore is similar to that of Baker No. 1 (pit 10), without bands. An analysis by W. F. Jennison (T–22) gives:—

	T–22
Fe	38.190
SiO_2	30.920
P	.678

This pit is about 2,200 feet south-west of No. 14; and while it is on the same range, the evidence that it is a continuation of the South mountain vein is in large part inferential.

On the line between the farms of M. and E. Armstrong and D. B. Armstrong, close to the Bloomington road, ore is reported similar to the South mountain vein and bearing fosslls. Search and inquiry failed to locate it. Its importance consists largely in the fact that, although 3,500 feet from the old pit beside Torbrook river just referred to, and itself of doubtful alignment, the ore in this Armstrong opening has been confidently correlated with the South Mountain vein. Such data as are available at present make it wise not to regard any ore west of Torbrook river as definitely referable to this vein.

It is, perhaps, to this western opening that the following analysis (T-23) refers, under the label "Armstrong farm, South mountain."

	T–23
Fe	54.71
Insol.	11.56
P	.43
S	.11

Scattered South Mountain openings.—It has been seen that on the property of J. L. Brown three ore beds have been reported, only one of which could be found.

On Torbrook river, close to the falls at the branching of the stream, is an old timbered pit, of which practically nothing can be seen to-day except decayed cribbing, and from which no sample could be taken (pit No. 16).

In the centre of the farm of M. and E. Armstrong is a small untimbered pit full of water (No. 17). The ore is a highly siliceous shell magnetite, similar in every visible way to that of the South mountain vein, and too small in amount to work. Sample 17 is a selected lot from a 6 to 7 ton dump of ore and slate, chiefly the latter. The least slaty ore was picked.

	No. 17
Fe	22.11

On the western side of the same property is pit No. 18, 3 feet deep and showing 15 feet of alternating slate and ore, the latter in narrow bands. Sample 19 is selected from a very small amount of the least slaty ore.

	No. 19
Fe	24.72

On the left bank of Torbrook river, one-fourth mile below the range of the South mountain vein, is a pit (No. 19) 5 feet deep. A small amount of ore is to be seen in a dump which is largely rock. The ore resembles the siliceous magnetite of the Baker and McConnell pits. Its breadth could not be measured. Sample 18 is a selected one from this ore.

	No. 18
Fe	23.61

Pit No. 20 is on the estate of M. Hoffman and G. Vidito, west of the Bloomington road. A number of openings are clustered together, one of them 10 feet deep and having a dump of about 10 tons of what appears to be chiefly a black, ferruginous quartzite. The openings all show the same rock in thick beds. The darkest and heaviest pieces were selected for sample 20.

	No. 20
Fe.	19.60

The following are analyses from various parts of South mountain. The exact localities and the analysts are unknown.

	T–24	T–25	T–26	T–27
Fe.	42.300	52.400	53.100	54.840
Insol.	10.390	9.410	7.970	10.870
MnO_2	.520	.230	.280	.410
P	.396	1.861	.530	1.452
S.	.015	.030	.028	.015
TiO_2.	....	....	....	.144

Broken and shaken ore 5 feet wide, similar to that of the South mountain vein, is reported in the western part of D. B. Armstrong's property, west of the Bloomington road.

Character of South Mountain vein.—Without accepting the somewhat sweeping generalization expressed in earlier studies, it is yet possible to be moderately certain of the continuity of the South Mountain vein for 8,000 feet; with considerable probability of finding it by present exposures for 10,000 feet, and a fair possibility of tracing it for 19,000 feet. Its continuity for a great distance, then, can be regarded as established.

The strike through its straightest course, between pits 10 and 15, is N. 60° E. Its dip at the surface varies from perpendicular to high northwest. In depth, as shown by the McConnell borehole, there would appear to be some tendency to blanket, the dip being 83° at 192 feet.

The quality of the South Mountain vein is not satisfactory. It is safe to say that the analyses quoted above from outside sources could not possibly be approached in shipments, the ore in bulk being much lower in iron and higher in insoluble material.

Cleveland Pits.

Heatley ore.—On the property of John Heatley, west of Nictaux river, are several openings, for the most part old and fallen in. Some of these are relics of early exploration; one or two were sunk by the Londonderry Iron and Mining Company in the course of general exploration. Pit No. 21 is one of these, about 30 feet deep and timbered, the ore of which was not seen in place. A large dump shows a siliceous magnetite, massive and without shells, of which sample 44 is a general test. Pit 22 is an older one on apparently similar ore, the breadth of the latter being reported as 11 feet.

The following are analyses from this property:—

T-28.—Massive, fine-grained magnetite; Geol. Surv., Can.

T-29.—No. 2, across 9 foot vein; L. I. & M. Co.

T-30.—No. 2, off dump; L. I. & M. Co.

T-31.—9 feet 3 inch vein, calcareous, compact, dark grey magnetite; L. I. & M. Co.

T-32.—25 inch vein, compact, dark grey magnetite; L. I. & M. Co.

T-33.—No. 4, 3 feet to 7 feet 6 inches, north of shaft; L. I. & M. Co.

T-34.—No. 4, shaft to 3 feet north; L. I. & M. Co.

T-35.—Sample A, No. 11, west end; W. F. J.

T-36.—Analyst, G. E. Arnold.

	No. 44	T-28	T-29	T-30	T-31	T-32	T-33	T-34	T-35	T-36
Fe.	31.12	44.13	29.40	31.350	40.430	42.160	42.16	10.38	37.200	40.13
Insol.	......	32.85	52.67	46.700	36.860	28.040	30.25	71.41	31.780	......
Al_2O_3.	......	......	......	.920	......	......	......	......	......	......
CaO.	......	......	......	2.110	1.820	2.900	......	......	......	......
MgO.	......	......	......	.310	......	......	......	......	......	......
P.	......	......	......	.810	......	......	......	......	1.427	......
S.	......	......	......	.006	.368	.051	......	......	......	......

Stearns ore.—The Page and Stearns property, between the Alpena road and the Nictaux river to the east, is the seat of the old Cleveland mines operated in the early seventies. No underground development was attempted here, nor in any other of the early work in the district.

A considerable number of occurrences are known, but most of the openings are filled in wholly or in part, and little or no ore is to be found. No recent work has been done on the property.

The iron has been divided into two groups in local usage, the northern or Taylor ore, and the southern or Doane ore. Of the latter the chief opening is pit No. 23, a trench 120 feet long and 5 feet deep. The ore is massive siliceous magnetite with no shells. Sample 43 is selected, the heaviest ore from a dump of 5 or 6 tons. The belt appears to be 6 feet wide, striking N. 42° E. and dipping 80° N.W.

Other analyses are also given, all from Geol. Surv. Can. From the appearance of the ore it is safe to say that these values, from ore then being mined, could not be even approximated to-day.

DETAILED MAP OF PITS,
ON
NORTH SIDE OF BASIN,
TORBROOK IRON DISTRICT.
Scale of Feet.
100 50 0 100 200 300 400 500 1000 1500 2000
J. Allen
Wm Ward
No 50
No 49
BLOOMINGTON ROAD
George Connant
Open trench
No 37
No 59
Edward Martin
No 48
Fault (Direction unknown)
No 36
J. Goucher
No 35
No 34
No 33
No 32
Open trench
No 46
No 47
Diamond Drill
No 45
H. Wheelock
Fault
No 44
No 43
Banks Estate
TO NICTAUX
Leckie Vein
Outcrop of Shell Vein
WHEELOCK MINE
F. Wheelock borehole
Maynard Wheelock
No 31
No 42 (Leckie Vein ?)
TORBROOK ROAD
Fletcher Wheelock
Arthur Wheelock
De Lacy Foster
No 41 Open trench No 60
Calyx drill
Diamond drill
Josephine Wheelock
L. I. & M. Co. Branch RY
Page and Stearns.
No 30
Open trench No 39
Borehole
Open trench
No 40
No 38
Hoffman shaft
M. Hoffman.
LECKIE VEIN
SHELL VEIN
No 28
No 27
No 29
No 26
George Holland
Stanley Brown
GRAVEL PIT
Brook
No 24
No 25
Annie Parker

	No. 43	T-37	T-38	T-39	T-40	T-41
Fe	24.81	54.220	57.930	58.050	53.140	59.11
SiO_2	....	14.970	17.210	....	....	11.64
Al_2O_3	....	5.530	....	....	....	....
CaO	....	2.700	....	....	....	....
MgO	....	.410	....	....	....	....
MnO_2	....	.860	....	....	....	....
P	....	.360	.160	.193	.172	.17
S	....	.069	.036	....	....	.09

The following are unidentified analyses from this region:—

T-42.—Average of four magnetites from Heatley, Baker and McConnell farms; Geol. Surv., Can.

T-43.—Average of two samples, Cleveland; N. S. Dep. Mines.

T-44.—Cleveland; L. I. and M. Co.

T-45.—Average of three samples, Cleveland; Geol. Surv., Can.

	T-42	T-43	T-44	T-45
Fe	52.22	57.99	50.770	55.49
SiO_2	....	....	18.950	....
Insol.	18.56	....	....	....
Al_2O_3	....	....	1.620	5.53
CaO	....	....	4.010	2.70
MgO	....	....	.620	.41
MnO_2	....	....	.488	1.05
P	....	.18	.647	....
S	....	.04	.080	....

Leckie Vein.

The north-western side of the basin presents four points of special interest: —(1) the character and persistence of the Leckie vein; (2) the same regarding the Shell vein above it; (3) inability, possibly owing to metamorphism, to recognize the former bed in the western end of the district, and the doubt as to the identity of the latter bed there; and (4) the very different set of ores and of strata east of the Torbrook-Wilmot road.

In the following description the order given above is preserved, as the general problems which the rocks suggest group themselves in that sequence. For convenience, however, the extensive underground development in the Leckie and Wheelock mines is treated under separate heads later. Plate 17 shows the locations of mines and openings in this part of the basin.

Leckie mine.—In this mine, the Leckie ore was first seen under such conditions as to make its characteristics clear. As first cut at the surface, it was but 18 inches thick. In the mine it ran from 4 to 6 feet, averaging nearly the latter. On rolls it was much thicker. It was lost on a pinch in the bottom of the mine; and the projection of the line of pinching upward and eastward to the surface would bring the eastern terminus of the ore 1,750 feet east of the Woodbury shaft, the one last used. The ore pinched out westward at the end of the mine, as shown in the longitudinal section. This may be due to the proximity of a boss of intrusive rock to the north-west; as a rock horizon used to trace the ore zone—a white quartzite, found constantly north of the Leckie and at a nearly fixed distance—is here seen to bend southward and even to cross the line of previous strike of the Leckie vein.

The iron ore in the mine is a compact red hematite, for the most part massive and without fossils. In a few instances shells were seen. The ore breaks more or less regularly into rhombohedral masses, but does not approach Bell island ore in the ease and regularity of fracture. The rock of the walls is a light green soft slate, with a distinctly greasy feel.

Pits toward Wheelock mine.—The Leckie mine extends onto the property of Archibald Banks. On the next two, that of W. R. Neily and that variously ascribed to Annie Parker, E. L. Robar and W. R. Neily, no ore has been found, either as drift or bed-rock.

The first pit, then, is the northern of two upon the farm of Stanley Brown (No. 24). The belt gives the following section (H. McI. Weir):—

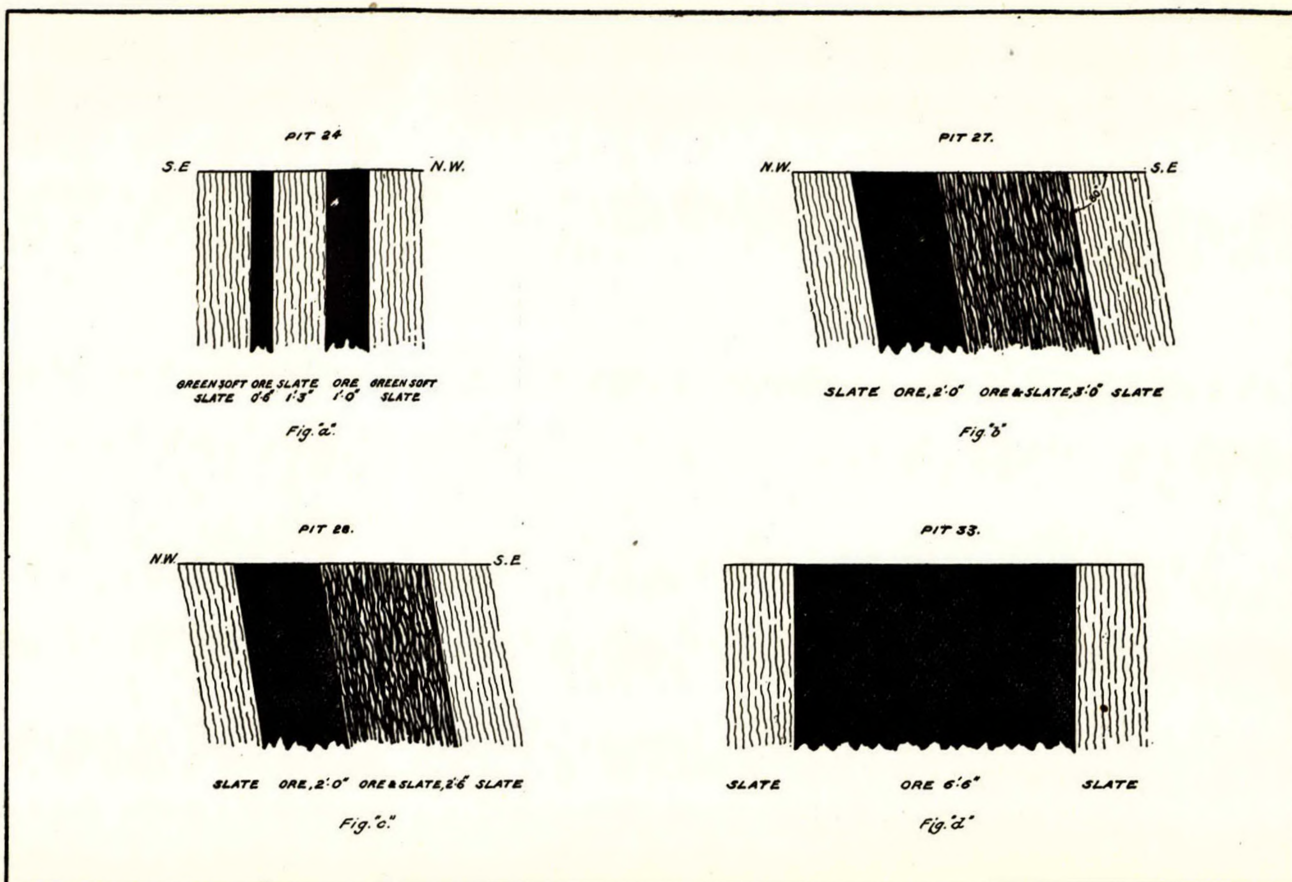
South wall, green soft slate.		
Ore....................................	1′–0″	
Slate....................................	1′–3″	
Ore....................................	0′–6″	total 2′–9″
North wall, green soft slate.		

The ore is red hematite, siliceous and very light in weight. A few fossil shells are to be seen. Scarcely 60 lbs. were to be found on the surface, and from this sample 7 was selected. No other analysis is available.

	No. 7
Fe....................................	30.81

On the property of George Holland are three pits, numbered from east to west 26, 27, 28. The first is an old timbered pit now fallen in. The ore is red hematite, slightly oölitic, and showing a few fossils. Light green clay partings of a concretionary nature are scattered through the ore, often containing a fossil nucleus. This is a feature at the Leckie mine as well. About 500 lbs. of ore can be found on the surface, and from this sample 6 was selected.

	No. 6
Fe....................................	47.620
SiO_2....................................	17.810
Al_2O_3....................................	5.230
CaO....................................	2.350
MgO....................................	.450
P....................................	1.170
S....................................	.054



Sections of ore in pits, Leckie and Shell veins.

Pit No. 27 is a well timbered shaft 23 feet deep. The ore belt is 5 feet, of which 2 feet are ore, the rest slate. The bed dips 80° S.E. The ore is red hematite, with a fine oölitic structure, and showing shells here and there. A dump contains 5 tons, of which 1.5 tons are of good grade; and from the latter sample 4 was selected. Another analysis is given, directly from the belt (T-46; N. S. Steel and Coal Co.). One by L. I. and M. Co. (T-47) is also given. T-48 and T-49 are published by the Annapolis Iron Co., marked merely as from this property. From the iron ratio, they are judged to be from the Leckie vein.

	No. 4	T–46	T–47	T–48	T–49
Fe	54.110	52.72	51.95	55.790	57.660
SiO_2	9.360	11.96	....	9.700	6.900
Insol	....	....	....	10.040	7.140
Al_2O_3	3.500	5.02	....	....	....
CaO	2.500	4.01	....	....	....
MgO	.430	....	....	....	....
P	1.310	1.43	....	1.020	1.030
S	.004	....	....	.051	.085

Pit No. 28, the western one on this property, is old and shows little at present. It was originally 9 feet deep, and exposed 4 feet 6 inches of mixed ore and slate. On the north side two feet were good. A dump of 100 lbs. was found, and from it sample 3 was selected.

	No. 3.
Fe	48.929
SiO_2	16.740
Al_2O_3	3.500
CaO	2.850
MgO	.580
P	1.270
S	.008

On the east side of the narrow property of M. Hoffman is the Hoffman shaft, where development of a mine was at one time in contemplation. Here the Leckie vein was met in a cross-cut, and a short drift run on it. The walls are 4 feet apart and unusually firm and good. Only 2 feet of good ore can be found, the remainder of the belt being poor ore and slate. The same light green slate occurs in the walls as at the Leckie mine. The strike and dip are like those in the Shell vein workings. A large amount of Leckie ore was found in the stock pile, readily distinguishable from the Shell ore. A general sample (No. 2) gave—

	No. 2
Fe	55.100
SiO_2	8.830
Al_2O_3	4.000
CaO	2.500
MgO	.280
P	1.070
S	.003

The Annapolis Iron Co. publishes the following analysis marked "Capt. Park, sample from Hoffman No. 1" (T-50).

	T–50
Fe	50.510
SiO_2	13.540
P	.990
S	.038

On the west side of the farm is an old pit regarding which no information could be obtained.

The next property is credited variously to Page and Stearns and to J. M. Taylor. Pit No. 30 is in the centre of this, and is situated nearer a mass of intrusive rock than any other part of the vein. It is 10 feet deep and timbered. The section is given (H. McI. Weir) as 3 feet 6 inches mixed ore and slate. The ore is good but narrow, slate bands being frequent. Only a few pieces of rather fossiliferous ore were found near the pit, and these may possibly have come from a trench on the Shell vein to the south. Sample 48 is from this. T-51 is from a dump, by N. S. Steel and Coal Co.

	No. 48	T–51
Fe	32.62	52.32
SiO_2		14.80
Al_2O_3		5.10
CaO		2.69
P		1.42

On the Josephine Wheelock farm is no opening upon this vein, nor on the DeLacy Foster farm to the west.

On the Maynard Wheelock property is a pit near the road (No. 31). Nothing could be learned from it upon inspection; but the N. S. Steel and Coal Co. report 4 feet of good ore. Note is made in the same source of a shaft on the Park vein, showing 1 foot 4 inches of poor ore. The name is used to the westward as a synonym of the Leckie, and in this instance the pit occupies the position expectable of an opening on that vein. If the Leckie is meant in this case, the sample noted below must have been taken at the wall, to judge from its quality. On the map of the area the two appear to be in range as though from the same vein. No personal knowledge of the appearance of the ore was gained.

T-52 is 1 foot 4 inches on the Park; N. S. Steel and Coal Co.

T-53 is from shaft on the Leckie; N. S. Steel and Coal Co.

	T-52	T-53
Fe.	21.12	52.00
SiO_2.	57.36	14.14
Al_2O_3	4.10	5.02
CaO.	6.01	1.94
P.	1.41	1.18

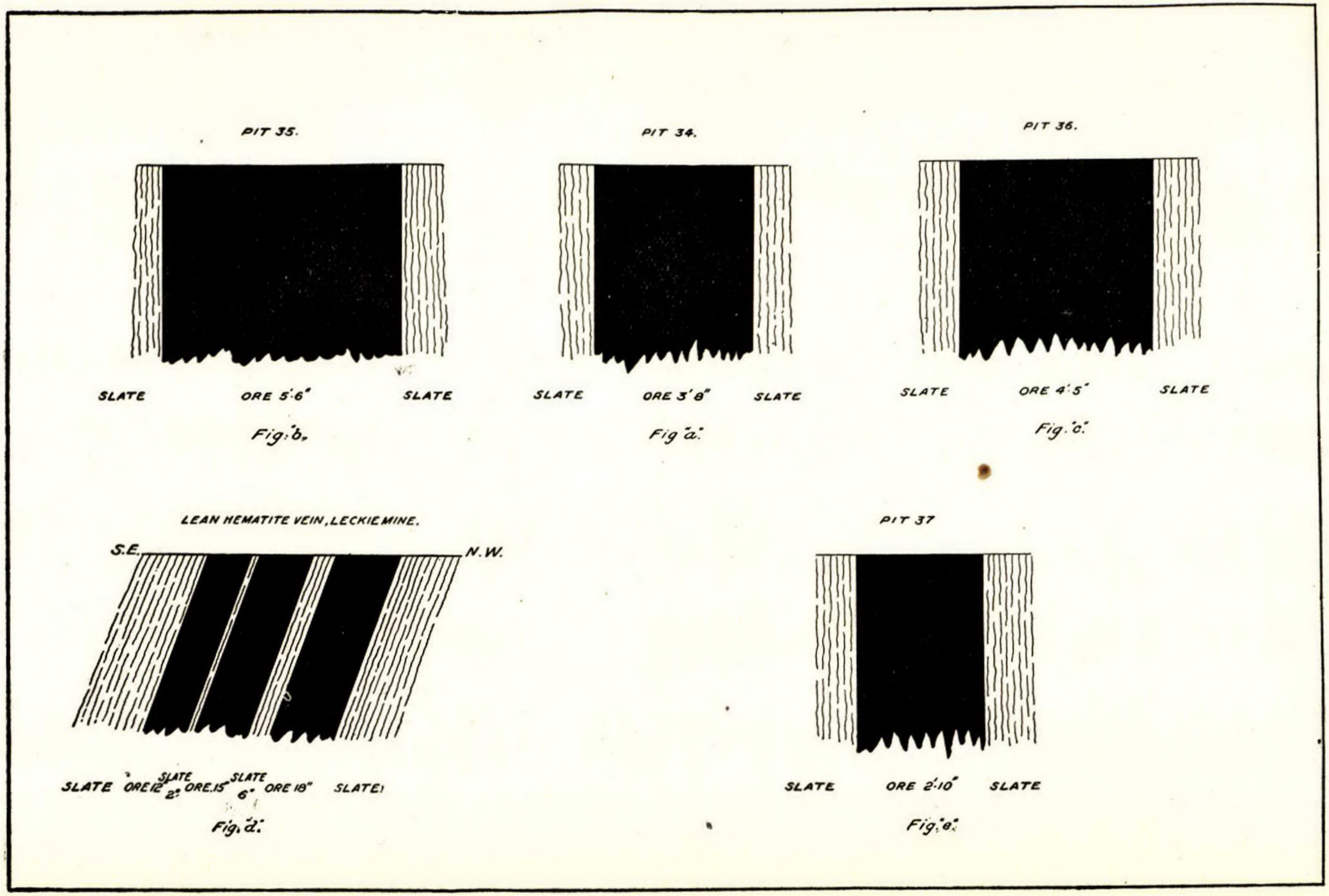
Borehole sections.—The easternmost borehole cutting the Leckie vein is on M. Hoffman's farm, giving 5 feet 2 inches of ore, of which 2 feet are probably good. The analysis is under T-54. The hole on the Page and Stearns place stopped at the Shell vein, as did both holes on the Josephine Wheelock property. On the Fletcher Wheelock farm a calyx drill hole was sunk through all the veins on the range. T-56 is the sample from the Leckie. The core showed a length of 11 feet 5 inches of ore, dipping S.E. at 70°.

	T-54	T-56
Fe.	29.00	52.80
SiO_2.	30.60	10.68
Al_2O_3	19.15	4.93
CaO.	3.56	4.57
P	.53	.95

Wheelock mine.—The Wheelock mine is developed upon the Shell vein; but a cross-cut was run to the Leckie, cutting 2 feet 6 inches of ore. Sample 164 is a general one of the ore in this cross-cut, and must be far below the average value; T-57 is an analysis at the time of first opening (L. I. and M. Co.)

	No. 164	T-57
Fe	18.20	45.47
Insol.	....	19.35

PLATE 19.



Sections of ore in pits, North side of basin.

Western pits on Leckie vein.—On the E. Banks estate, immediately west of the Wheelock mine, there are no openings upon this vein regarding which any authentic information can be obtained. Two analyses, labelled "red hematite, Woodbury farm," may be from this vein; L. I. and M. Co. (T-63 and 64).

	T-63	T-64
Fe	53.07	53.060
SiO_2	......	8.260
Insol.	12.55	12.450
Al_2O_3	......	4.190
CaO	......	6.300
MnO_2	......	.793
P	......	.557

The next farm, that of H. P. Wheelock, is on broken ground, as is that of J. Goucher. The Shell vein has been opened upon these properties, but search for the Leckie was unsatisfactory. A long cross trench may at one time have exposed the vein on the former farm, but a pit made on the spot which the Leckie should occupy exposed only a few stringers of ore in slate. That the vein has been identified at one time is indicated by the fact that 500 lbs. of massive hematite lie beside the trench, and from this sample 32 was selected. The ore is here found for the first time to be slightly magnetic, and its position could be ascertained readily by dip needle or magnetometer.

	No. 32
Fe	52.250
SiO_2	10.400
Al_2O_3	5.200
CaO	2.650
MgO	.330
P	1.440
S	.017

Since the field work for this volume ceased, much of the district has been acquired by the Annapolis Iron Company; and in the spring of 1907 search for the Leckie was actively begun on the Goucher and Martin farms. Information regarding this was kindly furnished by Mr. W. F. C. Parsons, their engineer. Pits 32, 33 and 34 on the former property gave respectively 6 feet, 6 feet 6 inches and 3 feet 8 inches of highly satisfactory ore.

On the property of E. Martin is an extensive fault. East of that and near the line fence is pit 35, opened by Mr. Parsons, giving 5 feet 6 inches of ore. Pit 36, an old one, was reopened for the author, showing 4 feet 5 inches of good grade oölitic hematite exactly like the Leckie ore east of the Wheelock mine except in being strongly magnetic. A statement by the N. S. Steel and Coal Co. givės 5 feet 6 inches of good ore, dipping 79° S.E. T-59 is an analysis by the company.

Two samples were taken: 28, a general sample from a 6-ton dump; and 45, a general sample across the belt. T-58 and T-65 are L. I. and M. Co.

	No. 28	No. 45	T-58	T-59	T-65
Fe	44.20	43.13	45.72	56.80	54.52
SiO_2	....	....	....	10.76	....
Al_2O_3	....	....	....	3.11	....
MgO	....	....	....	3.48	....
P	....	....	....	1.15	....

The following are analyses from the new Martin shaft, by the L. I. and M. Co. T-60 is a sample from a depth of 10 feet, T-61 from 15 feet, and T-62 from 20 feet depth.

	T-60	T-61	T-62
Fe	54.230	52.880	53.890
SiO_2	11.750	15.410	12.520
Al_2O_3	3.040	2.740	3.170
CaO	1.970	2.180	2.070
MgO	.360	.240	.410
MnO_2	.240	.180	.190
P	1.075	1.056	1.032
S	.049	.082	.091
H_2O	1.500	1.000	1.000

On the J. Allen property and near its east line is the last point westward at which the Leckie vein can be identified, even provisionally, at present. North of the long trench on the Shell vein are two pits, the more northerly of which has been regarded as probably on the Leckie vein; and analyses have been made with that in view. As will be shown later, it is on the whole more likely that this represents a vein which in the east is poor, and which is there called the Lean Hematite vein. The more southerly of the two pits (59) showed nothing of value, but was, from its position, judged to be on the Leckie vein.

Lean Hematite Vein.

Leckie mine.—In a cross-cut north from No. 3 level in this mine a small vein of low grade hematite was cut, and levels driven east and west for a few feet for testing purposes. The strike and dip are like those in the Leckie above the pinch. Between its hanging wall and the foot-wall of the, Leckie vein the distance is 40 feet. The belt averages 3 feet 9 inches wide, and is composed of three bands of ore and two of slate, which widen and narrow irregularly. The centre ore is better than the marginal. One section is as follows:—

Hanging wall.		
Ore	1′–0″	
Slate	0′–2″	
Ore	1′–3″	
Slate	0′–6″	
Ore	1′–6″	total 4′–5″
Foot-wall.		

Boreholes.—In the Hoffman borehole this vein was regarded as cut again, with a thickness of 2 feet 1 inch; but the log of the core as given would make it lie so short a distance below the Leckie that one hesitates to accept the figures, for they would bring the veins but 16 feet apart. No analysis is available.

In the Fletcher Wheelock calyx drill hole, east of the Wheelock mine, the Lean Hematite vein was cut in such a manner, like the two veins above it, as to lead at first to belief in a great thickening of the ore with depth. As will be seen later, this does not necessarily follow from the increase of section in the core over that at the surface. According to the measurements the vein would be 22 feet from the Leckie, and have a thickness of 14 feet.

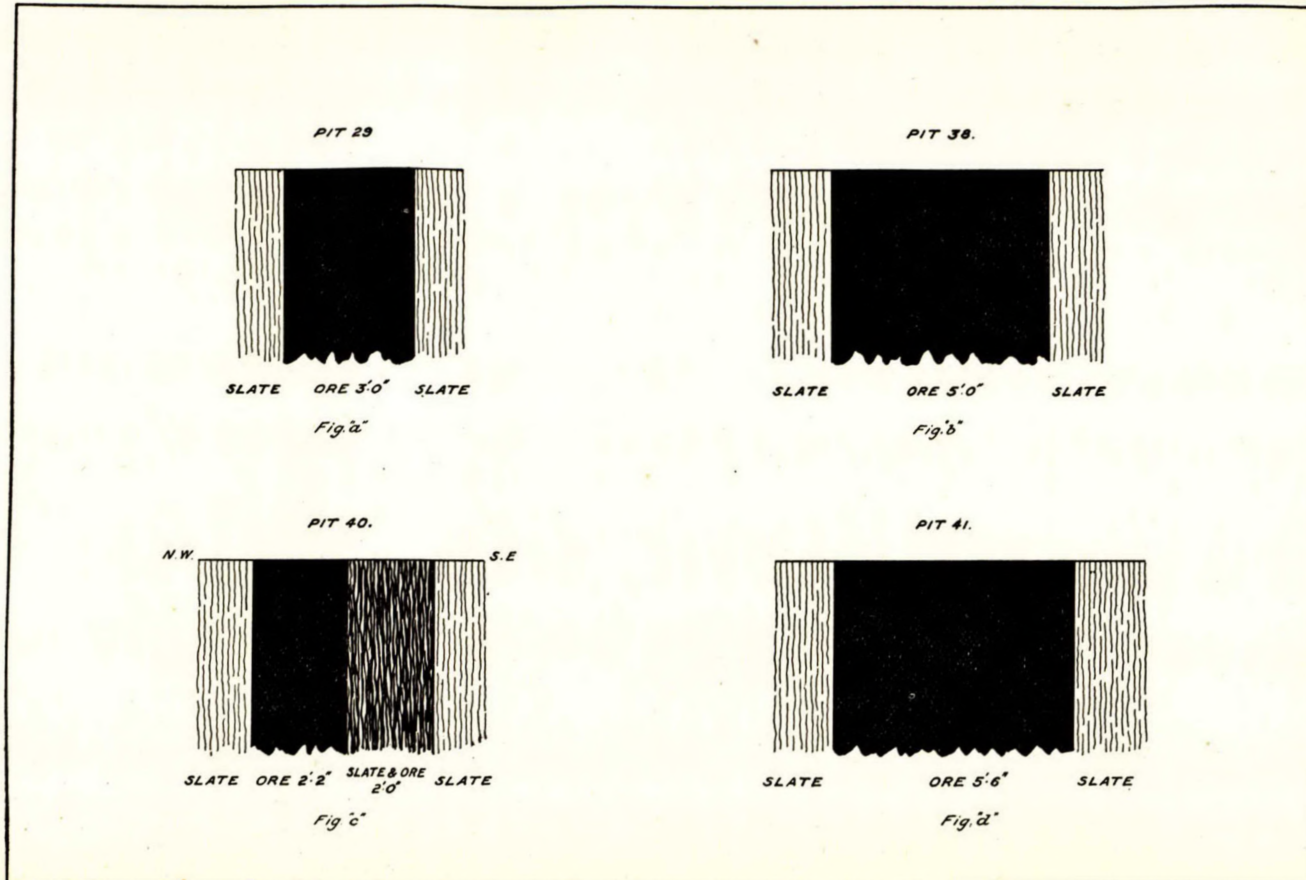
Allen pit.—Nothing further is known of this ore, unless the northern opening on the east side of the Allen property exposes it. It has been remarked that this opening is supposed to represent the Leckie, although the N. S. Steel and Coal Company cautiously refers to it in its sections as the "third vein."

In support of the idea that it is the Lean Hematite vein, however, may be cited (1) that no vein occurs elsewhere between the Shell and the Leckie; (2) that the intervals between the veins on the Allen property are such as the three veins bear to each other in the east. As to the first, the Shell vein is positively identified, having been worked in the trench in early years. This makes it probable that the order of beds northward would be: Shell, Leckie, Lean Hematite. As to the second, the intervals between the veins in the east are approximately 80 feet from the Shell to the Leckie, and 40 feet or somewhat less from the latter to the Lean Hematite vein. These are also approximately the intervals between the pits on the Allen farm.

The ore in this pit (No. 37) is 2 feet 10 inches wide, evidently of good grade, but looking in parts like the best of the South mountain ore. It is magnetic and carries a few shells. About 300 lbs. of ore on a dump were sampled by selection (No. 24). A general test was taken also across the belt (No. 49). T–63 is by L. I and M. Co.; T–64 by N. S. Steel and Coal Co.

	No. 24	No. 49	T–63	T–64
Fe	48.710	43.20	45.72	54.200
SiO_2	17.070	....	....	12.740
Al_2O_3	2.160	....	....	2.020
CaO	4.350	....	....	3.330
MgO	.430	....	....	....
P	1.680	....	....	.916
S	.006	....	....	....

PLATE 20.



Sections of ore in pits, on Leckie and Shell veins.

Shell Vein.

Leckie mine.—The Shell vein had become so well known in the central part of the Torbrook district, and its relation to the Leckie vein so well established, that it was fully expected, when a south cross-cut was run from No. 3 level in the Leckie mine, that this vein would be cut. At the position at which it should appear, the rocks showed approach to the axis of a pitching syncline; and, as is indicated in the description of the mine, the horizon which should contain the Shell vein turns across the axis at a depth from the surface of the ground less than that of the level, so that it would not appear in the tunnel at all (Plate 25).

Eastern pits.—The easternmost point at which the Shell vein has been cut in bed-rock is on the Stanley Brown farm (pit 25). At present nothing can be seen; but an early opening, made by the L. I. and M. Co., gave the following:—

South side ore	2′–4″	
Slate	2′–2″	
North ore	1′–9″	total 6′–3″

An analysis from the same source is given in T-66. The ore is full of shells, but, unlike that in openings to the west, is not magnetic. All the ore seen was too weathered to sample.

	T–66
Fe	49.650
SiO_2	13.360
Insol	21.460
P	1.110
S	.034

On the George Holland farm is one pit (29) and an old trench 350 feet long reaching to the west line fence. The pit is 8 feet deep, and showed 3 feet of ore without distinct partings (H. McI. Weir). On the dump only 200 lbs. were found, from which sample 5 was selected. The ore is in part oölitic, a characteristic that does not appear to the westward, and shows some slate in thin irregular bands. Some specimens are very calcareous. The Annapolis Iron Co. supplies analyses T-67 to T-71 inclusive. The N. S. Steel and Coal Co. reports the following section and analysis (T-72):—

Good ore	3′–0″	
Poor ore	0′–4″	total 3′–4″

	No. 5	T–67	T–68	T–69	T–70	T–71	T–72
Fe	46.610	36.27	45.14	48.68	39.31	48.18	48.60
SiO_2	14.400						16.20
Al_2O_3	4.130						5.96
CaO	5.980						5.88
MgO	.620						
P	1.280						1.24
S	.004						

Leaving out the Hoffman shaft for the present, two pits are in the western part of the M. Hoffman farm. No. 38 gave, according to Mr. Weir, 5 feet of good ore. According to a section by N. S. Steel and Coal Co. it gave:—

Good ore	3′-6″	
Poor ore	0′-6″	total 4′-0″

Analyses of these were made separately, T-73 being from the good ore, T-74 from the poor ore.

	T-73	T-74
Fe	42.60	40.36
SiO_2	17.34	12.12
Al_2O_3	5.54	4.33
CaO	9.05	15.26
P	1.32	1.19

This indicates the tendency, exhibited in places by the Shell vein, to become calcareous instead of siliceous in the leaner parts.

At the western edge of the property a trench at one time ran parallel with the fence, cutting all three ore beds. On the Shell vein a pit is still visible (No. 40). When fresh it exposed 2 feet 2 inches of good ore, with 2 feet of mixed slate and ore on the south side. No analysis is obtainable.

On the Page and Stearns place is a pit close to No. 30 which gave, when fresh, 4 feet 10 inches of ore. Sample 48 was selected from a small dump, the ore being badly weathered magnetite, highly fossiliferous. A fresh sample from the face gave, T-75; N. S. Steel and Coal Co.

	No. 48	T-75
Fe	32.62	48.00
SiO_2	....	15.10
Al_2O_3	....	5.10
CaO	....	2.97
P	....	1.30

On the Josephine Wheelock farm is a pit (60) which was to have been developed into a shaft, but operations upon which were suspended owing to the great encouragement offered by the Leckie vein pits on the Martin property to the west of the Wheelock mine. In this pit the section gave 4 feet of ore, dipping 85° S. E. and striking N. 78° E.

A trench has been opened on the vein, extending originally 200 feet east from the Wheelock west line. In this the west wall gave 2 feet 6 inches of ore.

On the DeLacy Foster farm is an indistinct trench at the east side, and pit No. 41. This is an old excavation, from which no data can be obtained at present; but it had been opened by the N. S. Steel and Coal Co., exposing 5 feet 6 inches of ore. Its analyses are as follows, T-78 being from the wall of the shaft.

	T–76	T–77	T–78
Fe	48.40	51.20	39.60
SiO_2	15.18	11.90	15.92
Al_2O_3	2.35	4.45	5.02
CaO	6.12	6.44	11.91
P	1.09	1.27	1.12

On the M. Wheelock place, close to the road, is an old pit in and around which nothing can be seen now. It was pumped out by one of the parties holding an option on the property, but was said not to show good ore. The section is not known. Two analyses with doubtful labels probably belong here. T-79 is marked No. 1, and T-80 No. 3; W. F. Jennison.

	T–79	T–80
Fe	34.82	46.49

On the Fletcher Wheelock property an old trench runs from the road to the west line. No definite information could be gained from it. Two analyses are as follows (W. F. J.):—

	T–81	T–82
Fe	49.86	50.160
SiO_2	14.66	12.900
P	.97	.890
S	.25	.109

Hoffman shaft.—Returning to the M. Hoffman property, a shaft has been sunk on the east side, to a depth of 156 feet on the Shell vein at an angle of 79° 30′. The walls and the angle of dip are extremely regular throughout. At 150 feet depth a drift was turned off and cross-cut run north to the Leckie vein, 80 feet. The Shell belt averaged 6 feet in width. The analyses made during sinking do not vary greatly, but were unusually low, and the furnace runs have been greatly above these. An average of 12 samples gives the following:—

	T–83
Fe	39.29
SiO_2	20.10
P	1.04

Boreholes.—Boreholes in abundance were drilled underground in the Leckie mine in search for the Shell vein, but without success.

The easternmost hole which cuts this ore was sunk upon the Hoffman property by the N. S. Steel and Coal Co., and was said to have cut 5 feet 6 inches of good ore and 9 inches of poor ore. T-84 and T-85 are analyses of the two classes.

	T–84	T–85
Fe	48.00	41.00
SiO_2	15.54	15.54
Al_2O_3	4.20	4.12
CaO	5.16	10.66
P	1.12	1.41

A shallow hole on the Page and Stearns lot is said to have encountered 5 feet of good and 2 feet of inferior ore. The L. I. & M. Co., give the following analysis for the core:—

	T–86
Fe	42.10
SiO_2	15.10
CaO	8.97
P	1.25

The Josephine Wheelock calyx drill hole has given rise to many analyses. The core ran 55.4 feet perpendicularly through ore which inclines at an average dip of 80°, giving approximately 9 feet 9 inches of ore; and was said not to have reached the wall when operations ceased. Sample 22 was taken from a small portion of the core remaining on the ground, probably from near one wall of the vein. Sample 41 was chipped from the lower 10 feet of the core. The main body was taken by the N. S. Steel and Coal Co., who put down the hole, and from whom analyses T-88 to 94 were obtained. T-87 is from a small sample by L. I. and M. Co., and T-95 is from the same source, probably near a wall. T-55 is from the N. S. Steel and Coal Co., labelled "Park vein"; but as the hole cut only the Shell vein, the analysis should be included here.

	No. 22	No. 41	T–55	T–87	T–88	T–89	T–90	T–91	T–92	T–93	T–94	T–95
Fe	33.10	30.22	48.60	45.98	45.80	42.94	43.34	45.00	48.38	50.40	45.00	40.04
SiO_2	.....	.....	15.84	14.46	12.36	19.26	19.84	11.58	11.14	11.16	.....	16.05
Al_2O_3	.....	.....	2.79	4.38	4.89	5.65	4.93	2.01	3.98	4.81	.....	.....
CaO	.....	.....	3.84	6.23	7.68	5.76	5.53	6.82	6.78	4.80	.....	.....
P	.....	.....	1.91	1.213	1.16	1.28	1.20	1.22	1.35	1.08	.....	.....

East of the calyx drill hole, a small diamond drill hole was sunk in 1906, at an angle of 45 degrees with the horizontal. The length of core in iron ore was reported as 6 feet 3 inches; this would give 5 feet 1.5 inches thickness. No analysis of the core is available.

The last is the calyx drill hole on the Fletcher Wheelock property. Here the Shell vein was reported as being 15 feet in thickness, whereas it was 6 feet at the surface. An analysis from near the foot-wall (150 feet depth), by the Dominion Iron and Steel Co., gave:—

	T–96
Fe	49.520
SiO_2	12.700
P	.916

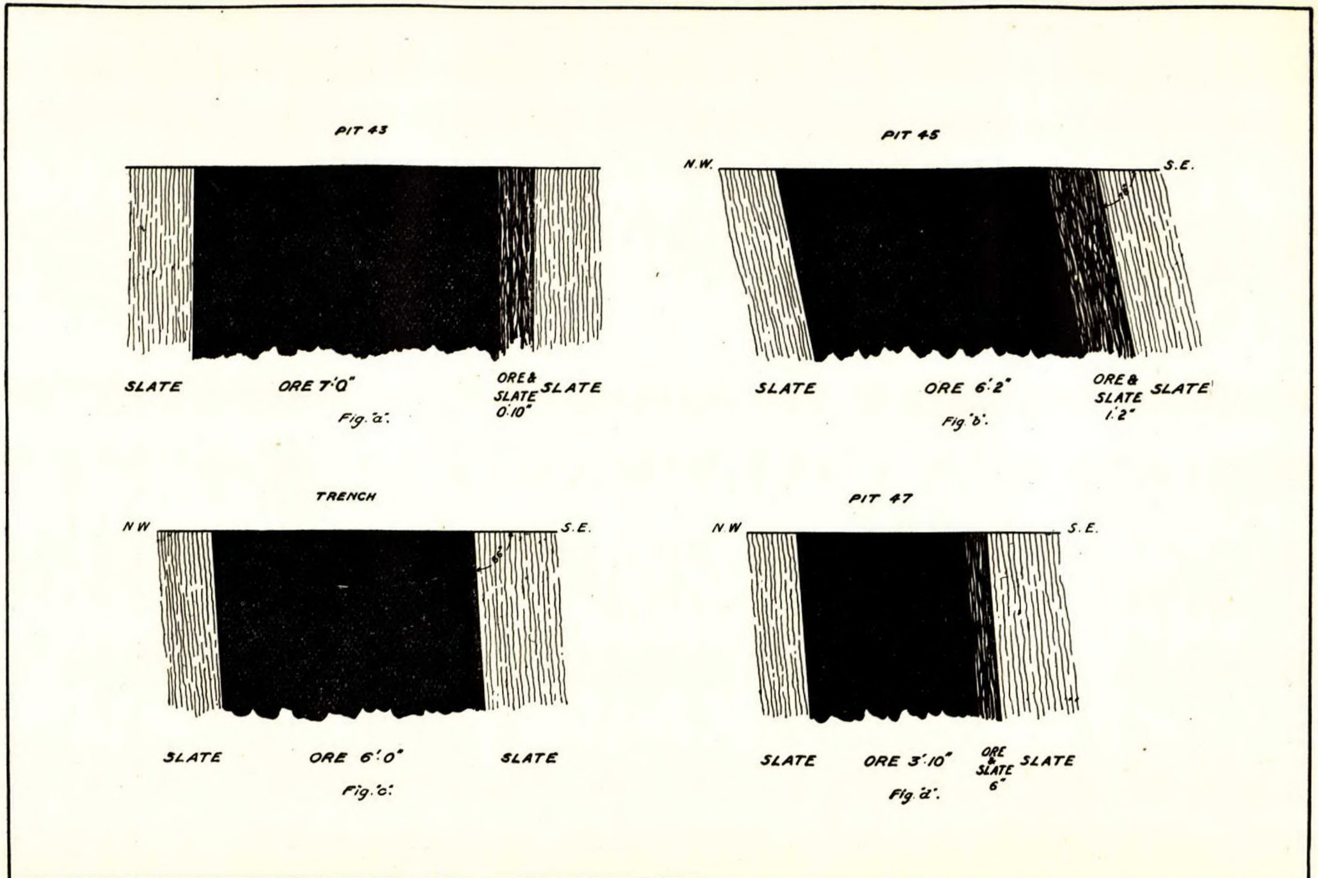
Wheelock mine.—Details of the occurrence and character of the ore in this mine will be given under separate heading later. The vein averages 7 feet thick on a straight dip, thickening to 15 or even 18 feet on rolls, and thinning out completely in two places where the vein takes a sudden turn. The general average of the ore for 1906 at the furnace, Londonderry, was:—

	T–97
Fe	42.74
Insol	17.46

For the month of May, 1907, it ran:—

	T–98 aver.	T–99 max.	T–100 min.
Fe	46.76	48.76	43.46
Insol	15.19	16.45	13.22

Western openings.—West of the Wheelock mine, on the E. Banks estate, is an open cut on the Shell vein, 175 feet long, and north of its west end a cross-trench, evidently in search of the Leckie vein. Neither is in condition to yield any information. A pit west of the west end of the cut, however, gave a section of 7 feet of ore and 10 inches mixed ore and slate on the hanging wall (No. 43). Sample 23 is a general section across the belt, the pit having been unwatered for the purpose. T–101 is from N. S. Steel and Coal Co., and T–102 from L. I. and M. Co.



Sections of ore in pits, on Shell vein.

	No. 23	T–101	T–102
Fe	49.800	56.60	51.39
SiO_2	11.320	10.24	....
Al_2O_3	7.000	3.77	....
CaO	3.800	1.94	....
MgO	.550	....	....
P	1.320	1.29	....
S	.002	....	....

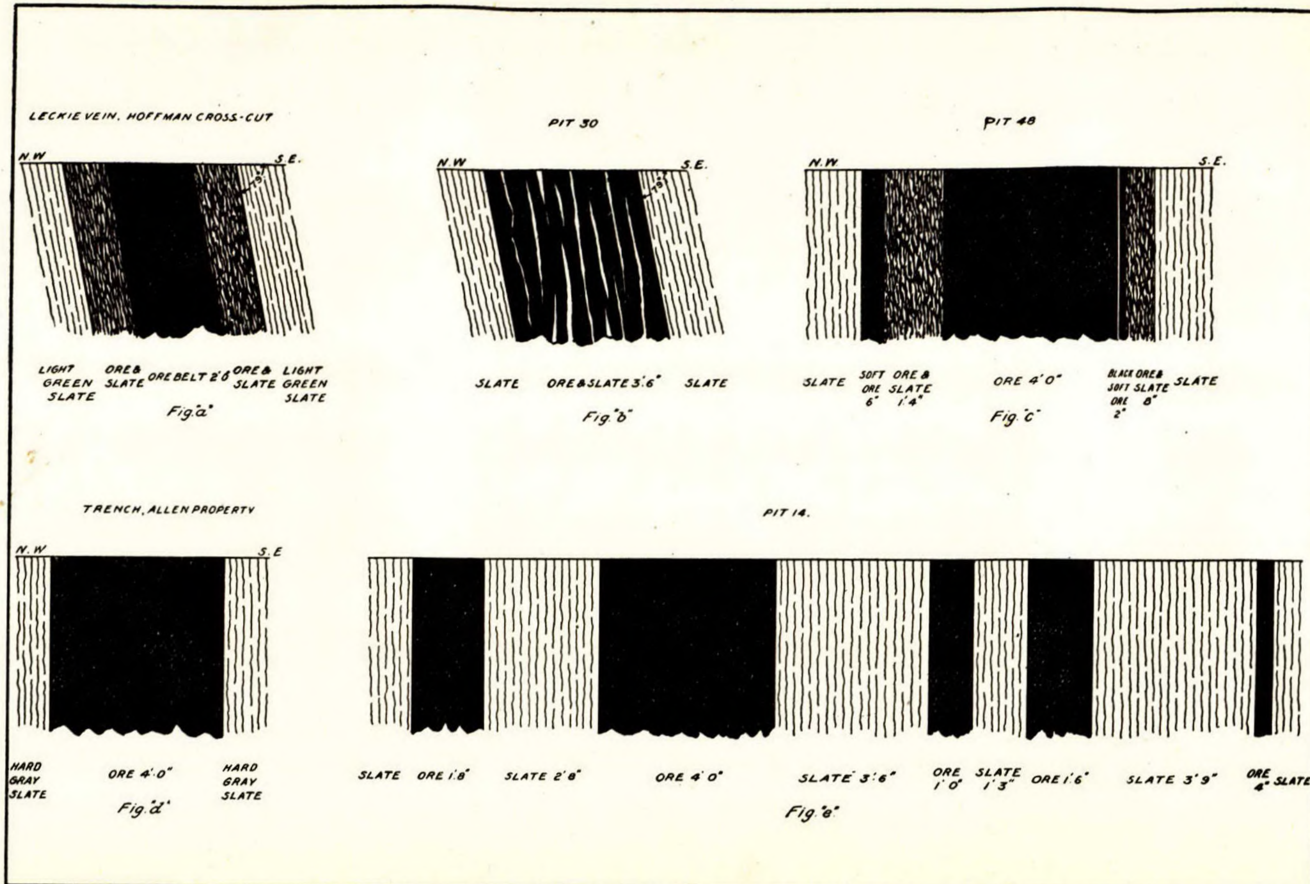
On the H. P. Wheelock farm a trench starts at the east line and runs intermittently to the east side of E. Martin's property. The ground in this vicinity is broken for 2,500 feet, as is shown by the offsets of the trenches and their irregularity of strike. A cross-cut on the Wheelock property gave location for pit No. 44, now in disuse. Beside it is a dump of 500 lbs. of shell ore, much of it weathered. Sample 32 was selected from the least altered parts of this, giving:—

	No. 32
Fe	52.250
SiO_2	10.400
Al_2O_3	5.200
CaO	2.650
MgO	.330
P	1.440
S	.017

Close to the Wheelock-Goucher boundary (which is not now marked by a fence), and in a short strip of solid ground along the line of the trench, is pit 45. This is a well cribbed shaft showing 6 feet 2 inches of good ore dipping 78° S.E. On the hanging wall, outside the ore belt mentioned, are 1 foot 2 inches of mixed ore and slate. Sample 33 is a general one across the main belt. T–103 is a general test of 5 feet 3 inches breadth (N. S. Steel and Coal Co.); T–104 is from L. I. and M. Co.

	No. 33	T–103	T–104
Fe	48.520	54.80	50.00
SiO_2	13.730	12.18	....
Al_2O_3	5.000	4.10	....
CaO	4.400	3.46	....
MgO	.550	....	....
P	1.690	1.07	....
S	.017	....	....

PLATE 22.



Sections of ore in pits.

On the west side of the Goucher farm, within a few feet of the line fence, a diamond drill hole was put down at an angle of 45°. No records are available, as they were so confused as to be valueless; but 6 feet 3 inches of ore are said to have been cut. This probably would amount to 5 feet 1.5 inches of actual thickness.

West of the boundary with the E. Martin property is pit No. 46, along the line of a trench which extends for 100 feet into the Martin place. This pit is old and untimbered, showing nothing at present. The N. S. Steel and Coal Co. had opened it and found 6 feet of ore, dipping 86° S.E. and giving the following analysis:—

	T–105
Fe	47.00
SiO_2	12.46
Al_2O_3	4.40
CaO	8.07
P	1.39

At the end of the trench is an untimbered hole (pit 47) showing a few hundred pounds of ore on a dump, from which a general sample (No. 27) was taken. Reopening of the pit gave opportunity for a general test of the belt, in sample 50. The vein is here 3 feet 10 inches broad, with 6 inches more of mixed ore and slate. T–106 is by N. S. Steel and Coal Co.; T-107 by L. I. and M. Co.

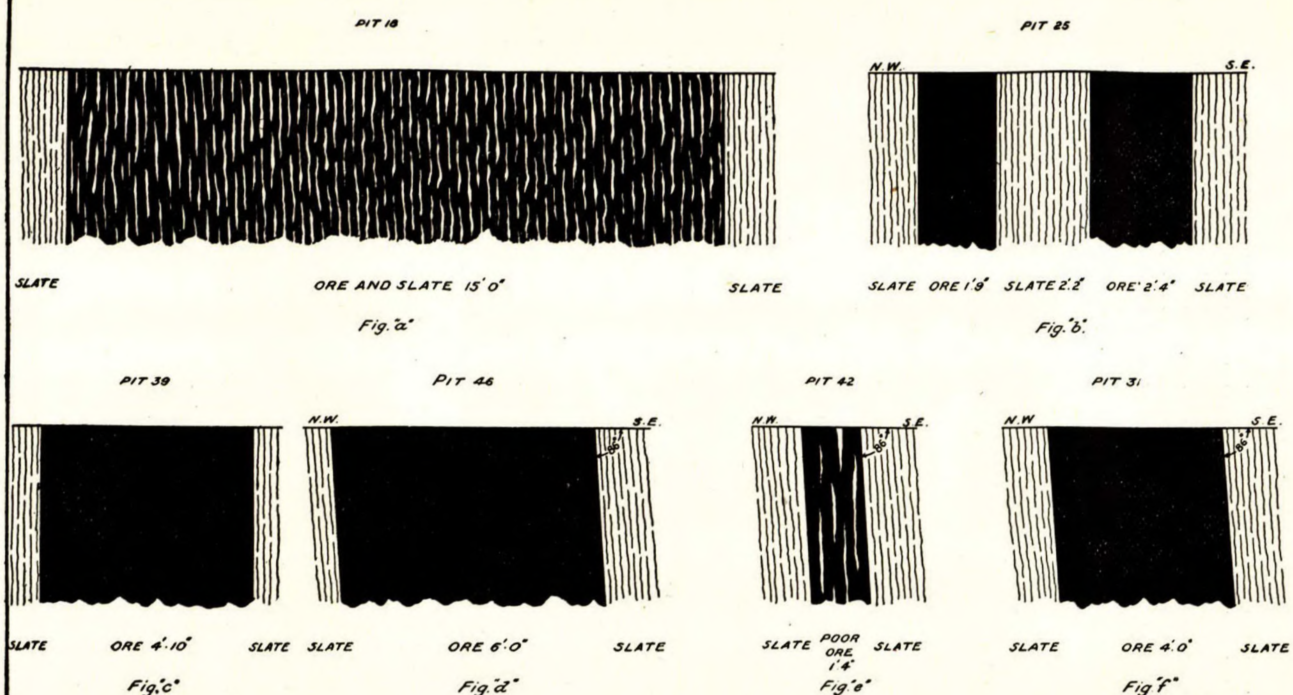
	No. 27	No. 50	T–106	T–107
Fe	53.320	43.50	50.80	48.21
SiO_2	9.680	....	10.08	....
Al_2O_3	4.690	....	3.98	....
CaO	2.750	....	6.44	....
MgO	.650	....	....	....
P	1.310	....	1.27	....
S	.005	....	....	....

Somewhat west of here is a right-handed fault, the offset being approximately 550 feet. Beyond it is pit 48, a surface exposure, which was freshened up by blasting. The section is as follows:—

North wall.		
Paint	0′–6″	
Ore and slate	1′–4″	
Hard ore	4′–0″	
Black paint	0′–2″	
Slate and ore	0′–8″	total 6′–8″
South wall.		

The ore is a shell magnetite with brownish red streak, like that in pits on the Shell vein to the eastward. Sample 26 was taken across the 4 foot belt.

PLATE 23.



Sections of ore in pits.

	No. 26
Fe	52.330
SiO_2	9.370
Al_2O_3	.350
CaO	7.800
MgO	.750
P	1.920
S	.003

From near the east line of the J. Allen property, obliquely to the line between the Allen and G. Conant properties, is a trench on this vein. The breadth of the opening is 4 feet, and its attitude practically vertical. The walls appear to be hard gray slate, and that on the south is extremely regular. No ore could be got from here and but one recent analysis is available. The workings date back to the days of the Nictaux furnace. T–109 is by Dom. Iron and Steel Co., labelled "Allen's; Shell ore."

	T–109
Fe	53.310
SiO_2	10.130
P	1.227

Ward Pits.

The above mentioned trench is the last evidence of the Shell vein until the Wm. Ward property is reached, west of the Bloomington road. The unknown interval is only 1,000 feet, but there is a considerable change in the distribution and condition of the ore.

How many beds are exposed here is not yet known with certainty. The one which has always been regarded as the Shell vein is opened by a trench one hundred yards long, with a shaft at the east end close to the road. South fifty feet from this is another vein, cut by two small shafts, and the ore is similar in every essential to that in the trench. Small pits south-west of the trench extend the north vein toward Nictaux river. No ore body of any kind is known to the eastward immediately south of the Shell vein; and the presence of two highly fossiliferous ore beds within so short a distance indicates either a different structure from that in the east or one or more new ore horizons.

The ore in both sets of openings is similar. It is a shell magnetite, the streak being black to slightly brownish and the rock finely granular to massive. There is none of the red streak characterising the Wheelock mine ore, nor is any considerable amount of the iron devoid of fossils. Much of the material on the dumps is light in color, showing an abundance of lime; and here better than elsewhere can the transition upward from ferruginous limestone to ore be noted.

T–110, N.S. Steel and Coal Co., is above the average for these veins.
T–111, from a belt 2 feet 6 inches wide ; W. F. Jennison.
T–112, No. 1, Ward trench; ditto.
T–113, No. 1 shaft; L. I. and M. Co.
T–114, No. 3 pit, stock pile; ditto.
T–115, No. 3 pit, hard magnetic ore; ditto.
T–116, No. 3 pit, hard compact magnetite; ditto.
T–117, No. 3 pit, 124 lbs. from dump; ditto.
T–118, No. 4 pit, first foot of ore; ditto.
T–119, No. 4 pit, 115 lbs. from dump; ditto.
T–120, No. 4 pit, gray calcareous magnetite, depth 14 feet; ditto.

	T–110	T–111	T–112	T–113	T–114	T–115	T–116	T–117	T–118	T–119	T–120
Fe	56.60	42.23	46.12	45.56	47.41	50.62	55.680	43.930	46.92	42.080	44.430
SiO_2	5.14	....	....	....	....	....	....	....	....	....	....
Insol	....	....	....	....	9.16	11.37	5.340	12.270	9.33	8.700	8.400
Al_2O_3	4.40	....	....	....	....	....	....	....	....	....	....
CaO	3.87	....	....	....	....	....	....	8.560	....	12.090	11.580
MnO_2	....	....	....	....	....	....	....	.082	....	.080	....
P	1.21	....	....	....	....	....	1.144	1.115	....	1.149	....
S	....	....	....	....	....	....	.011	.041	....	.115	.275

These are the best parts of the ore. In depth the iron decreases, and the lime increases to 18.16 in one instance. Averages of the openings sampled, which were those numbered 3 and 4 in the above list, and excluding some special tests of wall rock, are :—

	T–121	T–122
	No. 3	No. 4
Fe	49.660	41.05
Insol.	9.535	8.32

The first, especially, is too high to represent the shipping value of the ore.

As extremes may be cited Mines Branch samples 21, 30 and 31. The first is the best ore from a 10 ton dump at the east pit in the trench; the third is the lightest and most calcareous ore from the same pit; the second is the lightest ore from the pit south of the west end of the trench.

	No. 21	No. 30	No. 31
Fe	47.700	23.80	9.80
SiO_2	8.070	....	....
Al_2O_3	3.620	....	....
CaO	8.800	....	....
MgO	.900	....	....
P	1.270	....	....
S	.018	....	....

Scattered western openings.—Several occurrences of iron ore have been reported at isolated localities in this part of the field. Most of them are old openings which have lost all trace of the ore characteristics. The only clear instance observed was the manganic ore on the farm of J. B. Foster, east of Nictaux Falls (pit 51). Two pits are opened upon a brownish black magnetic ore, of very different fracture and appearance from that of the Leckie or Shell veins. Nothing could be learned of the belt, and sample 25 was selected from two small dumps. The ore is very variable, but runs high in manganese in most samples. A few analyses will indicate this tendency. T-123 is from Dr. E. Gilpin, Jr., the remainder are by W. F. Jennison.

	No. 25	T-123	T-124	T-125	T-126
Fe	30.32	18.47	34.840	25.46	6.08
SiO_2	....	33.50	26.630	32.12	....
CaO	....	3.00	....	....	....
MnO_2	....	9.80	....	....	21.27
P	....	....	.543	....	....

Eastern Ore Occurrences.

Spicer pits.—This term may be applied, as it is locally, to the pits on and near Torbrook river, north of those on the Peleg Spinney farm.

In the left bank of the stream, on the line between the Spicer and Banks estates, is a pit (52) from which has been reported hard hematite 3 feet thick. There is no ore near the pit, the surface showing only ferruginous quartzite with fossil shells. Clearing the face of the pit showed no ore, there being much decayed slate and a few thin bands of quartzite. An analysis of whatever ore could be found at the time gave Dom. I. and S. Co. the results in T-127 and T-128. The rocks adjacent to the seam are red slates chiefly, striking N. 60° E. and standing vertical.

	T-127	T-128
Fe	34.35	31.64
SiO_2	32.86	....
P	.86	....

South from this pit, above the bend of the river and on the David Banks place, a pit in the right bank of the stream is said to have uncovered 5 feet of a soft, low-grade oölitic hematite (53). At present nothing is to be seen. The strike of the rocks is as in the Spicer pit, dip 70° N.W. What is probably this ore gives analysis T-129, "Spinney, No. 2 bed," by W. F. Jennison.

	T-129
Fe	47.370
SiO_2	12.600
P	1.026

Spinney pits.—Several pits have been opened in the northern part of the Peleg Spinney place. No. 54 is a north-west and south-east trench, cutting the rocks at right angles. Some badly decayed coarsely oölitic hematite is to be found on a dump, mixed with ferruginous rock. Enough iron is present to make the drift ochreous for some distance from the ore. The rocks strike N. 72° E., dipping 88° S.E. This trench is stated to have cut 18 feet of good ore, and 11 feet of mixed ore and red slate on the north; but the claim could not be verified.

West of this pit is another, apparently upon the same ore (55). It is an old shaft, which was sunk chiefly in rock, if one may judge by the dump. The rocks are oölitic sandstone and slate, somewhat ferruginous. Scattered through the rock is more or less lean, light-weight ore, oölitic and containing many obscure shell markings. The north wall is a light greasy and green slate, very similar to that in the Leckie mine.

Three analyses give as follows; Dom. I. and S. Co.:—

	T–130	T–131	T–132
Fe.	37.24	48.150	36.38
SiO_2.	....	10.500	24.78
Insol.	....	11.500	....
P.	....	1.320	.881
S.	....	.048	....

Scattered openings.—Two pits were at one time opened, one on the eastern side of the Robert Neily farm and the second on the line between the Neily and Peleg Eaton farms. It is claimed that a bed of shell hematite 11 feet thick was cut, but there is no evidence of it at present. The ore is soft and of low grade. T-133 is labelled "Eaton No. 3"; W. F. Jennison.

	T–133
Fe.	32.60
SiO_2.	26.44

On the E. M. Barteaux place, near the road, a trench was cut for 2,000 feet parallel with the Wilmot road. The rocks met are reported to be red slates; and three beds of low grade iron, one 6 feet thick, are claimed to have been cut on the range of the ores at and near the Leckie mine. Three calyx drill holes were also sunk, but located no ore.

None of the ore veins opened east of the Leckie mine give promise of importance, and none of them show sign of being equivalents of the Leckie vein or the Shell vein, despite current belief.

Leckie Mine.

Location and history.—The Leckie mine, which has been until 1906 the mainstay of the Torbrook district, was located in 1891 upon the land of C. A. Banks, Samuel Barteaux, and Barrs (spelled also Barss) and Burns, at that part of the district called Torbrook Mines and close to the Torbrook-Wilmot road (see Plates 12 and 17). The original extent of land owned by the operators was small, and the ore was mined upon a royalty basis.

In the spring of 1891 two shafts, Nos. 2 (Woodbury) and 4 (Main or Barteaux) were opened, the shallow ore being worked by overhead stoping in one case, and underhand in the other. In the autumn Nos. 3 (no relic of which now remains) and 5 (Seary) were sunk. Four levels were driven from these shafts—No. 1, Perry, No. 2 and No. 3. These old workings have been inaccessible of late years. The stoping from shaft No. 3 was underhand, from No. 5 shaft overhead. The output during 1891, the first year of production, was approximately 10,000 tons.

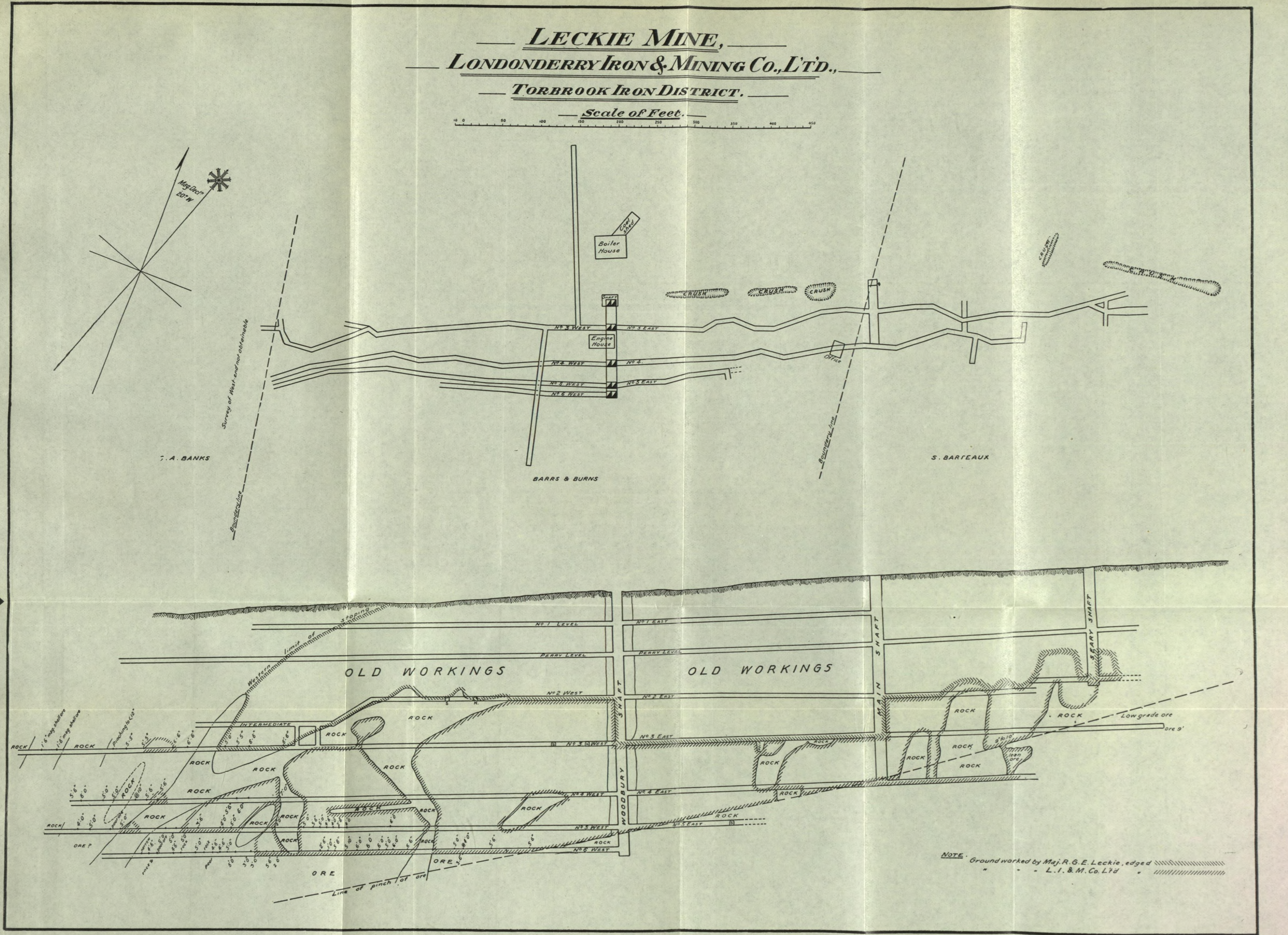
Early in 1892 a more complete equipment was installed, including a four-drum friction hoist for shafts 3, 4, and 5, two air compressors carrying six drills, and five steam pumps. No. 2 shaft had a separate installation of hoisting and pumping machinery, and raised somewhat over one ton per skip. The capacity of the mine in the spring of 1891 was 20 tons, in the spring of 1892 was 70 tons, and in the autumn of 1892 was 130 tons per day. In that year No. 2 shaft was cleared by a large Cornish pump, Nos. 4 and 5 by a small Blake pump.

The output until closing of the mine in 1896 was as follows:—

1891	10,000	tons
1892	18,000	"
1893	30,000	"
1894	21,590	"
1895	30,073	"
1896	19,944	"
Total approximately	130,000	"

Upon reopening in 1903, the Woodbury shaft was used permanently for all the hoisting, and the eastern ones abandoned. The reason for this was that downward the ore pinched out, at a shallow depth in the east and deeper in the west. Thus the old company had worked out the eastern end of the mine, while considerable ore remained in the western part. It must have been known by the vendors, however, that the ore was limited westward as well as eastward and downward, and that the mine could not be very long lived.

The operations since renewal of activity have been in the line of working downward to the squeeze, and westward to the limit of productive ore. In the course of this several lean rock shoots were encountered. If these extended upward into the old workings the fact was not made known, and all the shallow portions of the mine were marked "worked out" upon the stope sections. As already noted, the mine was regarded as exhausted in the autumn of 1906, and abandoned.


LECKIE MINE,
LONDONDERRY IRON & MINING CO., L'T'D.,
TORBROOK IRON DISTRICT.
Scale of Feet.
Mag. Decln 20° W
Boiler House
Coal Shed
Engine House
Shaft
No 3 West
No 3 East
No 4 West
No 4.
No 5 West
No 5 East
No 6 West
CRUSH
Office
Boundary line
Survey of West end not obtainable
A. BANKS
BARRS & BURNS
S. BARTEAUX
OLD WORKINGS
No 1 LEVEL
No 1 EAST
PERRY LEVEL
No 2 West
No 2 East
No 3 East
No 4 East
INTERMEDIATE
ROCK
ORE
WOODBURY SHAFT
MAIN SHAFT
SPARY SHAFT
Western limit of stoping
Low grade ore
Line of pinch of ore
NOTE. Ground worked by Maj. R. G. E. Leckie, edged
" " " L. I. & M. Co. L'td "

Underground development.—Reference to the large scale map and stope section (Plate 24) will show the chief features of the mine. From the Woodbury shaft to the Main is 333 feet; thence to the Seary is 330 feet. Eastward from here the old workings extend at least 165 feet; and at several places there are surface crushes where the ore was stoped out to the grass-roots.

The old workings are not well known, as no progress map of the mine up to 1896 could be found. It is certain, however, that the Perry level extended westward into the Banks property for at least 210 feet, or 1,240 feet from the centre of the Woodbury shaft. This gives a total length in the old workings of approximately 2,070 feet.

No. 1 level had a depth below the surface of 44 feet on the floor; and extended from the Main shaft to the Woodbury (No. 1 east), thence westward (No. 1 west) for a distance of approximately 475 feet, giving a total length of 785 feet. It is said that the ore ceased at 400 feet west of the Woodbury shaft.

The Perry level lay 39 feet below No. 1, or 83 feet from the surface, and extended, as already noted, 2,070 feet. The ore is reported to have given out approximately 435 feet west of the Woodbury shaft.

No. 2 level is 56.5 feet below the Perry, or 139.5 feet from the surface. No. 2 west runs 317 feet west from the Woodbury shaft; No. 2 east runs to the Main shaft and beyond, a total distance of 538 feet. Here it stops, being replaced 15 feet above by a short level which runs 75 feet to the bottom of the Seary shaft, and 165 feet farther east. At its west end, No. 2 west level drops by an incline 32 feet to the Intermediate level. This carries the level to a point 105 feet beyond the Banks property line, giving to the level and its dependencies a total length of 1865 feet.

No. 3 level is 59 feet below No. 2, and 198.5 feet from the surface. At the time of reopening in April, 1903, No. 3 west ran 470 feet from the Woodbury shaft. Subsequently it was run approximately 300 feet farther, until the ore appeared to have given out permanently. Eastward the level ran 360 feet east of the Main shaft and past the Seary, which stops at a depth of 153 feet from the surface. Thus No. 3 has a total length of 1,467 feet.

No. 4 level is 64 feet below No. 3, or 262.5 from the surface. No. 4 west was, when the mine was abandoned in 1896, 420 feet long. Recent work added between 180 and 200 feet to this, the last part of the tunnelling being in rock. No. 4 east has been lengthened from 310 to 540 feet. No. 5 level is 43 feet below No. 4 or 305.5 from the surface. No. 5 west was 300 feet in when the L. I. and M. Co. began work, and has been run to 640 feet. No. 5 east, which was but 65 feet long in 1903, has been increased to 160 feet, chiefly in lean ore and rock.

No. 6 is a short level, driven since 1903, approximately 670 feet in length. It is only 28 feet below No. 5, or 333.5 feet below the surface. The Woodbury shaft, the only one reaching this level, has a shallow sump below.

Thus it will be seen that the ore body as a whole is triangular in longitudinal section, the apex being at the east end; a short side resulting from the irregular pinching out on the west, and a long side by the very even pinching below.

The old workings, or those completed before reopening in 1903, comprise all the ground above No. 2 level, except a small body at the east end. In addition, they include the ground between Main and Woodbury shafts above No. 3 level. The exact boundaries of some of these workings are not obtainable with certainty, owing to the lack of any completed stope section showing the operations of the old company, and the absence of any final map and stope section, completed to the date of closing of the mine. For the same reason, the plan does not show the levels as far west as they are drawn in the section.

Details of levels.—Of No. 1, Perry, No. 2, and Intermediate levels, nothing is known. In the work of the old company under Major R. G. E. Leckie, No. 3 east was driven in about 5 feet of ore, No. 4 east in 4 feet, and No. 5 east in 3.5 feet of ore.

With regard to the newer work, speaking broadly, No. 3 west ran in 5 feet of ore, No. 4 west in 4.5 feet, No. 5 west in 4.5 feet, and No. 6 in 4 feet.

No. 3 east had previously been worked to the Main shaft. East of this shaft 82 feet, rock was struck in the floor and continued for 55 feet. This is part of a rock wedge which reaches No. 2 level 92 feet from the shaft, there continuing for 50 feet, but not rising into the roof of the level. At 200 feet from the Main shaft rock is again met and continues to 565 feet, where the break crosses the floor, pitching west at 10°. Beyond this pinch is a wide low-grade ore belt, somewhat different in character from the main ore body. The excavation of this constitutes almost the only work in this level by the Londonderry company. At the surface of this tunnel is low grade ore 9 feet in breadth, giving Fe 30.3. The ore wedges out rapidly, both walls coming in at the same place and meeting in the middle.

In No. 3 west level rock was encountered in the roof approximately 257 feet from the Woodbury shaft, the contact reaching the floor at 266 feet. The rock continued to 335 feet, replaced there by a band of ore, less than ten feet on the horizontal but rising in a toad-stool shape. Beyond is rock for approximately 70 feet, nearly to the boundary between the Barss and Burns and the Banks estates. Statistics of thickness of the ore are obtainable from this point on, and are to be found upon the accompanying stope section. The bed practically ends at 660 feet from the shaft. At 725 feet a narrow band of feebly magnetic shell ore is met, which disappears again at about 775 feet. This is interesting, as showing the shelly nature of the Leckie vein despite an almost entire absence of fossils in the main part of the mine, and as indicating how far east extends the magnetic quality of the ore, not noticeable in the Leckie mine but very characteristic to the westward.

For No. 4 east few progress data can be had. The break or pinching of the bottom meets the floor of the level at 295 feet from the centre of the Woodbury shaft. Beyond this, what ore is met is lean. Two rock shoots were developed east of the Main shaft as shown on the stope section, one of them being a downward continuation of the large horse found in No. 3 east.

Close up against No. 3 level, immediately above the pinch, the ore had swelled in a roll to 9 or 10 feet. This is characteristic, as the pinch is merely a roll, in the bottom of which the hanging wall turns to a steep dip sooner than does the foot-wall. In the old workings rock had been met in the roof 175 feet east of the Woodbury shaft, continuing for 25 feet but not found in the floor. This shoot ran upward and eastward into No. 2 level, where record of it is lost.

In No. 4 west a rock shoot had been encountered in the floor of the old workings 75 feet west of the Woodbury shaft, continuing for 50 feet. It does not rise into the roof, but runs obliquely westward and downward to No. 5 west level. At 245 feet was met a narrow portion of the large rock shoot of No. 3 level, here 30 feet across and rising westward instead of eastward. This is the only conspicuous case of a rock mass which does not pitch westward.

At 410 feet a second shoot was entered, the east wall pitching east to the floor of the level, then turning to perpendicular. The rock continues for approximately 30 feet. At 525 feet is the foot-wall of a large barren interval which would seem to correspond to two horses in No. 3 level above, the foot-wall coming down at an angle of scarcely more than 10° from the east. Ore does not come in again for approximately 75 feet. At 210 feet a narrow shoot comes in from above, 20 feet across. Such ore breadth notes as it has been possible to get in this and other levels have been placed upon the stope section. According to the latest available data for No. 4, the level was still in ore; and its final length was not determined.

No. 5 east level struck the break or pinch at 80 feet in the roof, and at 25 feet in the floor, the remainder of the work and a short cross-cut south being in rock. The pinch was shown in the Woodbury shaft at 330 feet depth on the west side. No further details of the ore and rock in No. 5 east are available.

No. 5 west ran in ore to 125 feet, where a small horse was met, 30 feet in length, not reaching the floor but extending upward and eastward to No. 4 level. Thence to 240 feet the level was in ore, but no details of its breadth can be given. At this point a narrow chimney of rock is encountered, passing downward to No. 6 and upward becoming part of the large anvil-shaped shoot which reaches to No. 2 level. In No. 5 the rock extends only 6 feet. At 420 feet a third rock mass begins, 30 feet through. This reaches downward to No. 6, there dying out; and upward it carries to No 4 and beyond, roughly perpendicular. From 460 to 490 feet rock was pierced, which does not appear to reach levels above or below. At 600 feet begins a shoot which is in many ways remarkable, bifurcating upward so as to reach No. 3 in two places, and possibly connecting with the anvil-shaped shoot above No. 3. This is followed for 45 feet, some fair ore being found beyond. At approximately 720 feet, however, rock appears to close in on the vein permanently.

No. 6 level was not driven east of the Woodbury shaft, as the latter was already in rock; and the level ran west for 90 feet before ore came in at the roof. Ore was penetrated to 245 feet, where for 20 feet the downward extension of the anvil-shaped shoot was cut. Thence to 420 feet ore was worked, in some places of full width and in others narrowing to one foot, the remainder of the belt being rock. For 15 feet at this point is the bottom of a rock wedge, which is met in full width in No. 5 level, but which does not reach the floor of No. 6. Thence to 625 feet come alternations of good and poor ore, wide and narrow, in places mixed with rock. Beyond this point only rock was met.

Below No. 6, between the level and the pinch, some ore was stoped out, but it was relatively unsatisfactory in quantity and quality.

Structural conditions.—The above somewhat tiresome details of the workings have been given, because of their bearing upon the general structure of the ore body. This body may be described broadly as a bed, triangular in longitudinal outline. Its general strike is N. 65° E. Its dip in the upper portion is 79° S.E.

To the east the old upper levels east of the Seary shaft appear to have stopped in ore; and it is to be presumed that ore continues most of the distance to the point where the pinch of the bottom intersects the surface, about 1,750 feet north-east of the Woodbury shaft. At the most, however, this would give but a small tonnage.

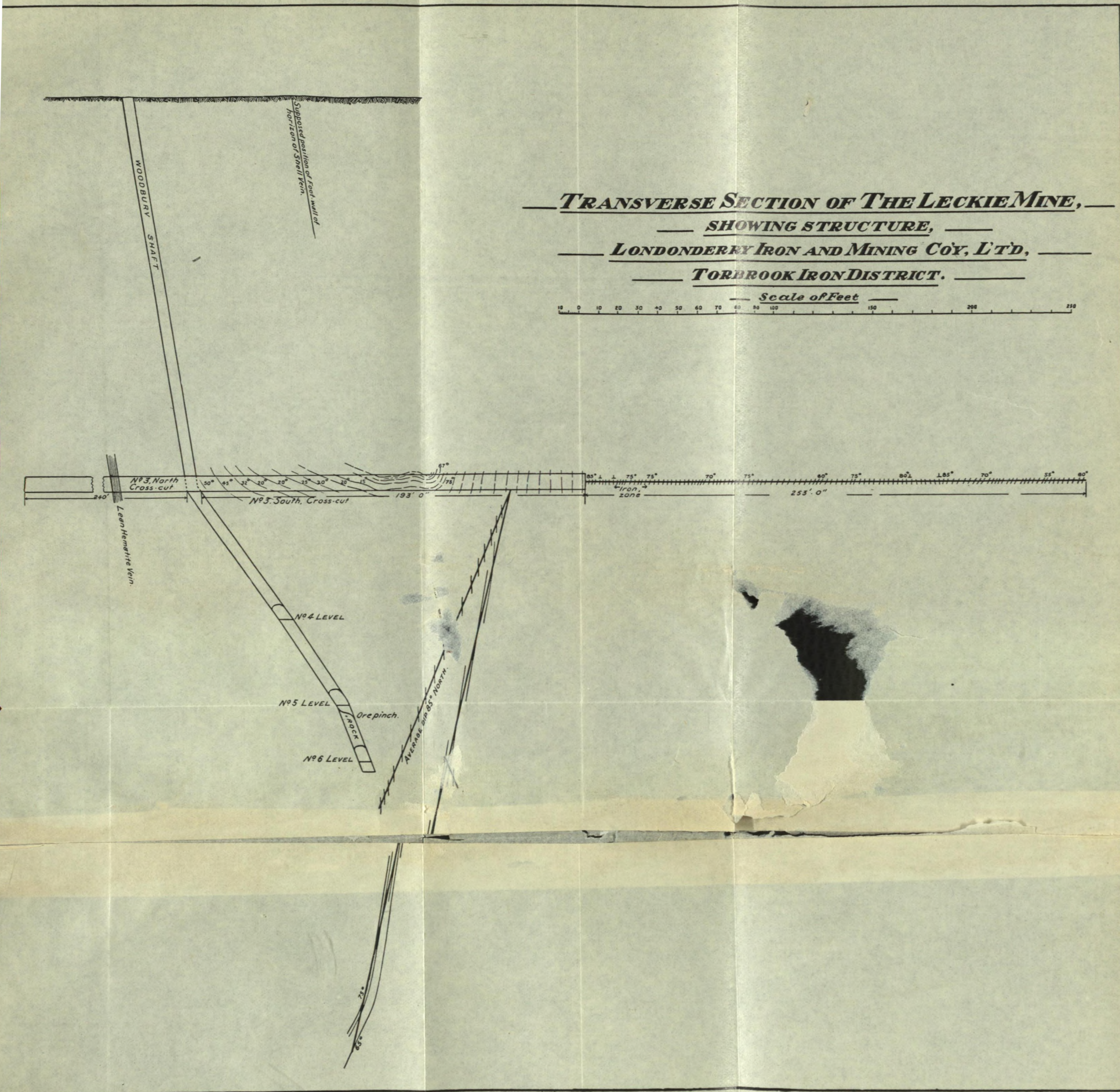
To the west the ore pinches out in an irregular line from the surface downward. It is difficult to assign an average pitch to this, but it is roughly 35° in the parts in which it could be observed continuously, as at No. 3 west level. Wherever the pinch is encountered in the levels the foot-wall comes in against the hanging wall, the latter deviating slightly if at all. The line of junction of the walls always pitches west, even though steeply in some places. There is some similarity between this termination of the ore and the pinch at the bottom of the body, but in the former there is no accompanying thickening of the bed.

The flat break or pinch at the base of the ore body is formed by a more or less rhythmic change of dip of the walls. The hanging wall first plunges from an average dip of 38° to 58° or 60°, then to vertical. The foot-wall increases its dip from 38° slightly, thus thickening the ore in a roll; then flattens rapidly almost or quite to the horizontal, coming against the hanging wall so closely as to cut off the ore, then turning to the perpendicular and following the hanging wall.

Below the pinch the walls do not again separate, as far as seen. In the eastern end of the mine, where a very low grade ore was found to a maximum width of nine feet, it is said that the walls did not visibly separate, the ore gradually replacing wall rock.

A general transverse section of the mine at the Woodbury shaft is shown in Plate 25. Others would differ from this chiefly in the depth at which are encountered the considerable flattening of the vein and the pinch. Sections made farther east would show both at less depth, and *vice versa*.

The flattening of the vein is accompanied by thickening of the ore, in places up to 12 feet. Indeed, there are two and possibly three rolls, the ore in these being thicker and of better grade, a leaner and narrower portion lying between them. The pitch of the rolls follows closely that of the pinch.


TRANSVERSE SECTION OF THE LECKIE MINE,
SHOWING STRUCTURE,
LONDONDERRY IRON AND MINING CO'Y, L'T'D,
TORBROOK IRON DISTRICT.
Scale of Feet
Supposed position of foot wall of horizon of Shell Vein.
WOODBURY SHAFT
No 3. North Cross-cut
No 3. South. Cross-cut
240'
193' 0"
Lean Hematite Vein.
Iron zone
253' 0"
No 4 LEVEL
No 5 LEVEL
No 6 LEVEL
Ore pinch.
ROCK
AVERAGE DIP 85° NORTH.

Any relation between the rock shoots and the rolls and pinch, if present, is obscure. The description and stope section show an irregularity of distribution, attitude, shape and size of the rock masses; but there is a marked tendency to a westward pitch, and in some cases this approaches that of the line of pinch of the ore. There is no rhythm or regularity of frequency of these shoots; but they are practically always accompanied by a right-handed twist or offset, never becoming a fault.

In these shoots the walls hold well apart; so that, while the ore may be thin or wanting, the belt retains much of its normal breadth. In other words, the rock in part represents incomplete replacement of portions of a stratum by the iron. Whether this replacement occurred before the folding of the bed is not an economic problem. The important points are, first, the irregularity of form and distribution, and second, the frequent sudden offsets in the bed, which accompany but do not account for the rock shoots.

Physical and chemical character of ore.—The ore from this mine, and at the eastern end of the Leckie vein generally, is a fine-grained red hematite without definite structure for the most part, and even in texture from side to side of the vein. Very rarely oölitic structure may be noticed. It has been spoken of as devoid of shell fossils, but during the period of this investigation scarcely a day passed without fossils being seen. Still they are relatively rare here as elsewhere in the bed. In the western part of the district one cause for the uncertainty and difficulty of correlation of the veins and for working out the structure lies in the increasing number of shells which the Leckie ore held in that direction, this being nearly *pari passu* with the increase of magnetic quality which it shows. At the Leckie mine there is almost no magnetic ore.

As a rule the ore in this mine is easily separated from the rock walls. This is in part because the hanging wall consists of 18 inches of soft, green and highly decayed slate, the foot-wall two feet of the same material; in part because the impregnation ceased along well defined boundaries. Beyond both walls is hard blue slate. Most of the ore breaks in clean rhombohedral blocks.

A general average analysis of the ore has already been given, based upon a large number of tests, practically all from shipments. It will be noted that the iron runs high for a Clinton ore, comparing favourably with the lower of the Bell Island veins.

From the large number of available analyses the following are selected to show the range of the different components:—

T-200 General sample of several cars of hematite; Smaill, Londonderry.

T-201 Sample of massive red hematite; ditto.

T-202 Hematite, fine ore and rock matter; ditto.

T-203 Sample from cars at Ferrona; R. E. Chambers, New Glasgow Coal, Iron and Railway Company.

T-204 Sample from stock piles; ditto.

T-205 Signed "J. T. D."

The above are all from the ore during the first period of operation, or down to 1896.

The dates of the following are not known, but the analyses are from Londonderry:—T-206, 207, 208, 209, 210, 211.

T-212 Geol. Surv., Can., Rep. for 1873–4.

No.	Fe	SiO_2	Insol.	Al_2O_3	CaO	MgO	MnO_2	P	S
T–200	55.60	12.00	....	5.08	1.90	.35	.380	.430	.110
T–201	50.27	....	18.13	3.59	....	1.00	.280	......	......
T–202	47.50	....	26.50	5.00	....	....	3.020	......	.228
T–203	53.24	14.45	....	4.85	....	....	....	1.250	......
T–204	48.43	15.68	....	12.47	....	....	....	1.350	......
T–205	55.74	....	10.12	....	....	....	trace.	.087	.078
T–206	50.89	14.30	....	3.62	1.60	trace	.525	1.170	......
T–207	50.33	13.50	....	5.90	2.70	trace	.695	1.010	.033
T–208	50.40	14.09	....	5.18	3.60	....	....	1.240	......
T–209	53.90	10.85	....	5.75	3.00	....	trace	1.490	.038
T–210	49.42	14.40	....	7.07	....	....	.150	1.380	......
T–211	57.29	7.18	....	....	....	....	....	.880	.034
T–212	50.09	18.94	....	....	....	....	....	.790	.050

The following are partial analyses from various sources, but practically all made at Londonderry:—

T-213 Average of 30,000 tons shipped to Londonderry down to 1896 (too optimistic); R. G. E. Leckie.

T-214 Average of seven cars; Smaill.

T-215 ditto.

T-216 Sample from S. Barteaux, Londonderry.

T-217 Best lump ore; Smaill.

T-218 Red hematite, "Sample from Barteaux;" Smaill.

T-219 Sample of red hematite; Smaill.

T-220 Average sample; Smaill.

T-221 Shipment sample; Annapolis Iron Company, quoted from old records at Londonderry.

T-222 Average of seven cars; ditto.

T-223 Shipment sample; ditto.

T-224 ditto.

T-225 Sample from S. Barteaux; ditto.

T-226 Torbrook mines dump; ditto.

T-227 Average of shipments, Feb. 1–5, 1892; Londonderry.

T-228 Ditto, Feb. 1–14, 1892; Londonderry.

T-229 " Feb. 14–29 " "

T-230 " Mar. 1–15 " "

T-231 " Mar. 16–30 " "

T-232–237 inclusive, samples from cars; Londonderry.

T-238 Sample of nine cars; Londonderry.

T-239 Sample of cars, Jan. 3, 1905; Londonderry.

It is unfortunate that there are very few analyses extant the exact location of which is indicated. The few which follow are instructive as far as they go, but show the poorest parts of the mine.

T-240 No. 5 level east.
T-241 " " west. These are both above the pinch.
T-242 No. 3 level west, solid ore.
T-243 " " west, mixed ore and slate.
T-244 " " east.
T-245 " " east, red ore.
T-246 " " east, hematite with clayey fracture.
T-247 Face of No. 3 west level; Jan. 17, 1906.
These two are below the pinch, in the wide, lean belt.
T-248 Cross-cut, No. 5 level; Feb. 12, 1906.
T-249 ditto.

No.	Fe	SiO_2	Insol.	MgO	P	S
T-213	55.00				.3-.4	
T-214	59.00		12.87			
T-215	56.45	13.88				
T-216	58.09					
T-217	61.38		10.28	.427	.180	
T-218	60.72		11.00		.399	
T-219	52.24				.798	
T-220	56.00					
T-221	60.72				.770	
T-222	56.00					
T-223	55.74				.180	.080
T-224	52.44				1.660	
T-225	59.76	10.22				
T-226	40.43					
T-227	52.72					
T-228	53.63					
T-229	55.90					
T-230	56.50					
T-231	55.45					
T-232	51.89		13.26			
T-233	48.83		15.65			.113
T-234	34.07					
T-235	48.65					
T-236	52.46					
T-237	49.69					
T-238	42.30					
T-239	41.85		18.07			.096
T-240	46.58					
T-241	52.88					
T-242	37.44				.894	
T-243	39.47				.994	
T-244	28.06		42.27			
T-245	34.05		30.35			
T-246	30.36					
T-247	39.08	19.39				
T-248	46.46	22.11				
T-249	42.78	24.60				

The only Mines Branch analyses are as follows. No more samples were regarded as necessary in view of the abundance of shipment analyses available:—

No. 39, carload sample from shaft pillars; No. 46, skip-load sample from underhand stoping below No. 6 level.

	No. 39	No. 46
Fe	54.220	45.000
SiO_2	11.860	22.000
Al_2O_3	3.120	3.670
CaO	1.900	3.400
MgO	.259	.520
P	.900	1.480
S	.019	.119

Continuity of ore body.—It has been noted that the Leckie ore body is limited in all directions, as far as known at present. In considering the detailed structure of that part of the district, however, it is seen that the strata at and near the mine lie on the north side of an unsymmetrical syncline, the limbs of which are much stretched and thinned. In the case of the ore bed, this action amounted to a complete separation of the stratum, the lower part being carried downward.

It is regarded as probable that the continuation of this body, perhaps in a much thickened condition, may lie at the bottom of the syncline, the ore occupying the trough.

Wheelock Mine.

Location and characteristics.—This opening on the Shell vein, still in an early stage of development, is situated on the Fletcher Wheelock property, the shaft being but a few feet south-east of the Torbrook-Nictaux road (see Plates 12 and 17).

Access to the workings is through one shaft, 7 by 14 feet, sunk on an inclination of 79° 30′, the angle at which the ore dips at the surface. At present two sets of levels are being driven; set No. 1 is at a vertical depth of 80 feet. No. 1 east at the end of March, 1907 was 445 feet in length, No. 1 west 370 feet. No. 2 lies at a vertical depth of 150 feet. The east level was 280 feet long on March 28, 1907, the west 330 feet.

In the shaft, as will be seen later, the ore ran into the hanging wall a few feet below No. 1 level. As a consequence, a cross-cut to locate the ore was run southward at the depth now occupied by No. 2 level. At the bottom of the shaft a drift was carried east for 20 feet and a cross-cut north 137 feet, intersecting the Leckie bed on the way. The first drift south for the Shell vein is really a continuation of this cross-cut.

Shaft section.—The average dip of the shaft to the depth of No. 2 level is 72°, the slope varying somewhat (see Plate 27). Down to No. 1 level the ore follows the shaft, turning somewhat southward at this point, so that the dip is reduced from 79° S.E. to 54°. At six feet below the floor of the level the foot-wall flattens for part of the width of the shaft, resuming its normal

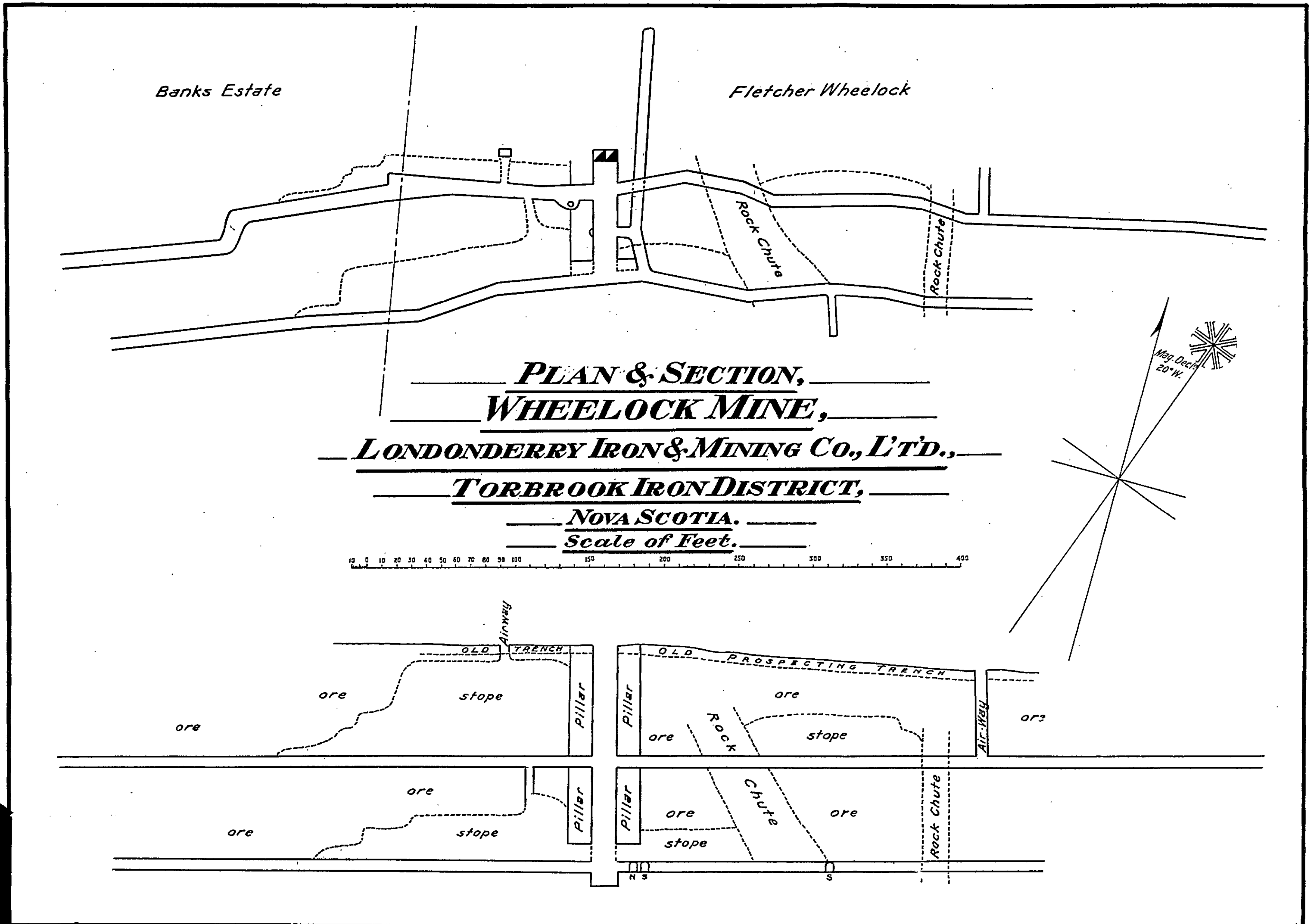

Banks Estate
Fletcher Wheelock
Rock Chute
Rock Chute
PLAN & SECTION,
WHEELOCK MINE,
LONDONDERRY IRON & MINING CO., L'T'D.,
TORBROOK IRON DISTRICT,
NOVA SCOTIA.
Scale of Feet.
10 0 10 20 30 40 50 60 70 80 90 100 150 200 250 300 350 400
Mag. Decl. 20° W.
Airway
OLD TRENCH
OLD PROSPECTING TRENCH
ore
stope
ore
Pillar
Pillar
ore
ore
Rock
stope
Air-Way
ore
ore
Pillar
Pillar
ore
Chute
ore
ore
stope
stope
Rock Chute
N S
S

PLATE 27.

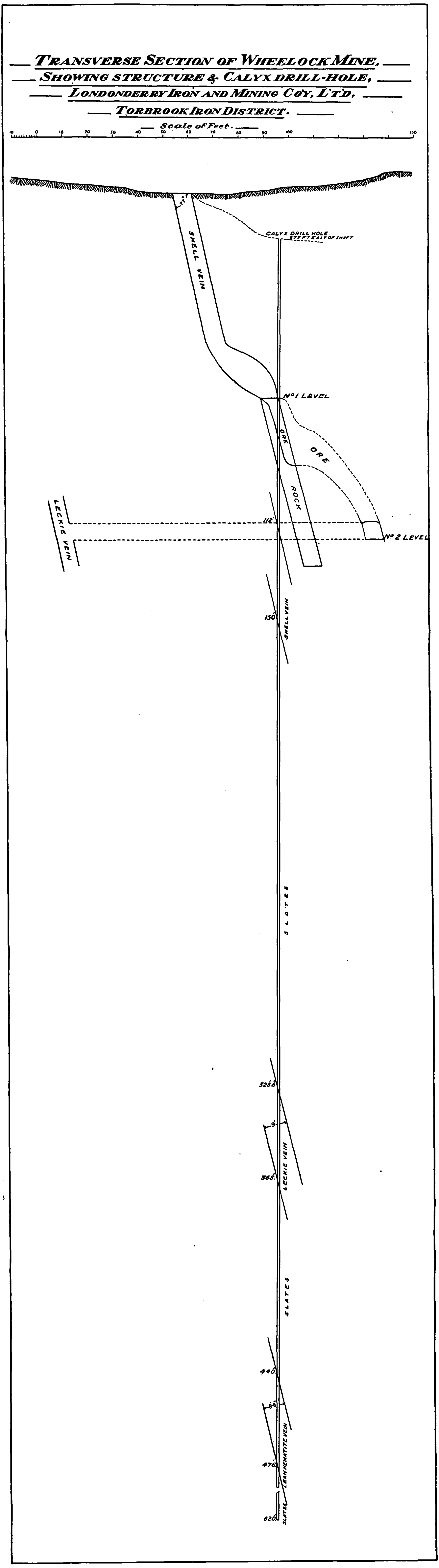
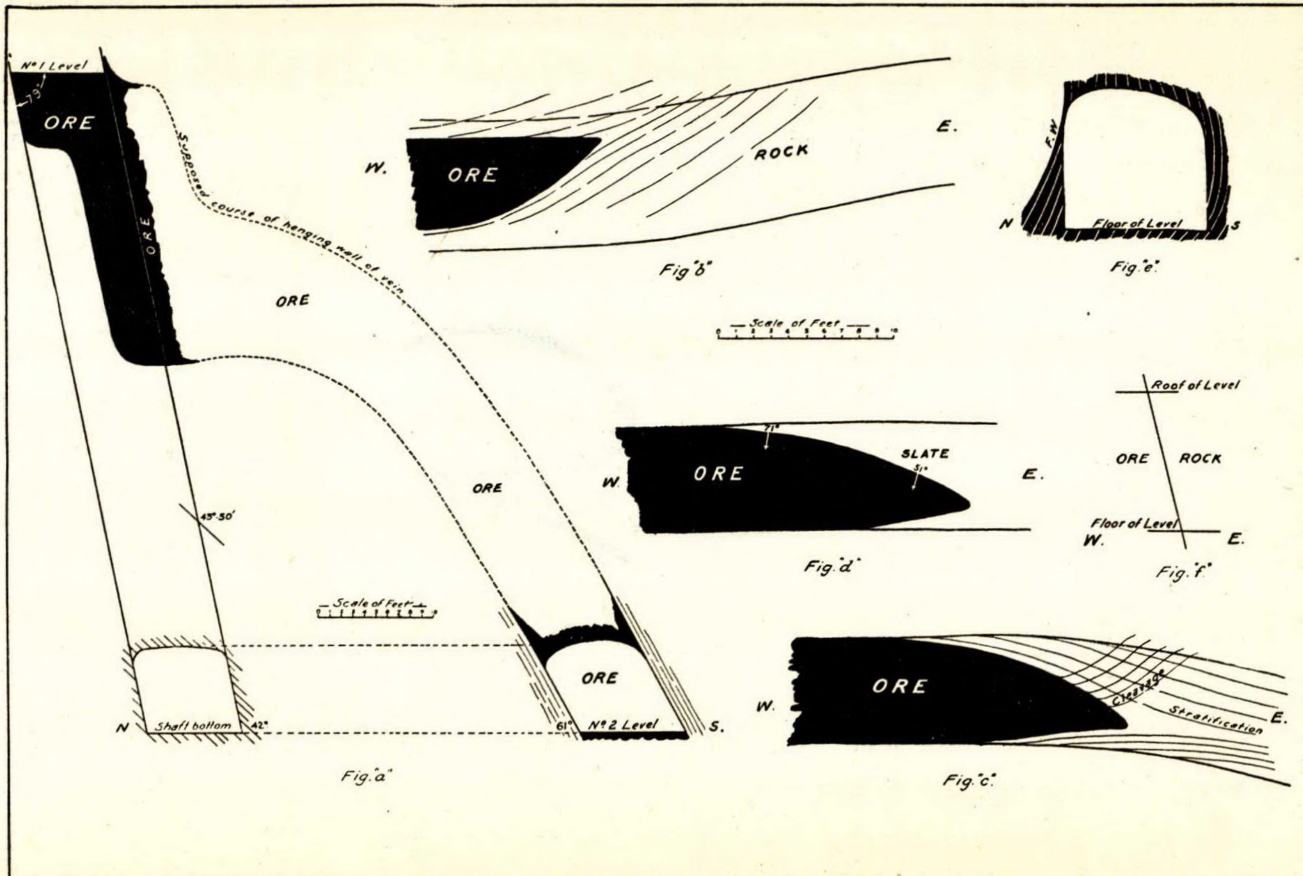

TRANSVERSE SECTION OF WHEELOCK MINE,
SHOWING STRUCTURE & CALYX DRILL-HOLE,
LONDONDERRY IRON AND MINING CO'Y, L'T'D,
TORBROOK IRON DISTRICT.
Scale of Feet.
10 0 10 20 30 40 50 60 70 80 90 100 150
CALYX DRILL HOLE
SHELL VEIN
No 1 LEVEL
ORE
ORE
ROCK
LECKIE VEIN
112'
No 2 LEVEL
150'
SHELL VEIN
SLATES
326.5
LECKIE VEIN
365'
SLATES
440
476'
LEAN HEMATITE VEIN
620
SLATES

PLATE 28.



Structure sections in Wheelock Mine.

dip once more. At a depth of 28 feet below the level it turns flat and even assumes a low north dip, passing rapidly across the shaft and out of view to the south-eastward. The cross-cut south found the ore at a distance of 30 feet, measured between the centres of the drifts. At the bottom of the shaft the dip is 42° S.E., the strike N.47° 30′ E. (magnetic). At 40 feet from the upper level the dip has increased but 1° 30′. The changes at and near the foot-wall of the iron ore are rapid, the dip increasing at once in the ore so that at 22 feet from the upper level it is 57°, which is maintained for ten feet, from which to the top there is an increase to 79° followed by the flattening six feet below the level.

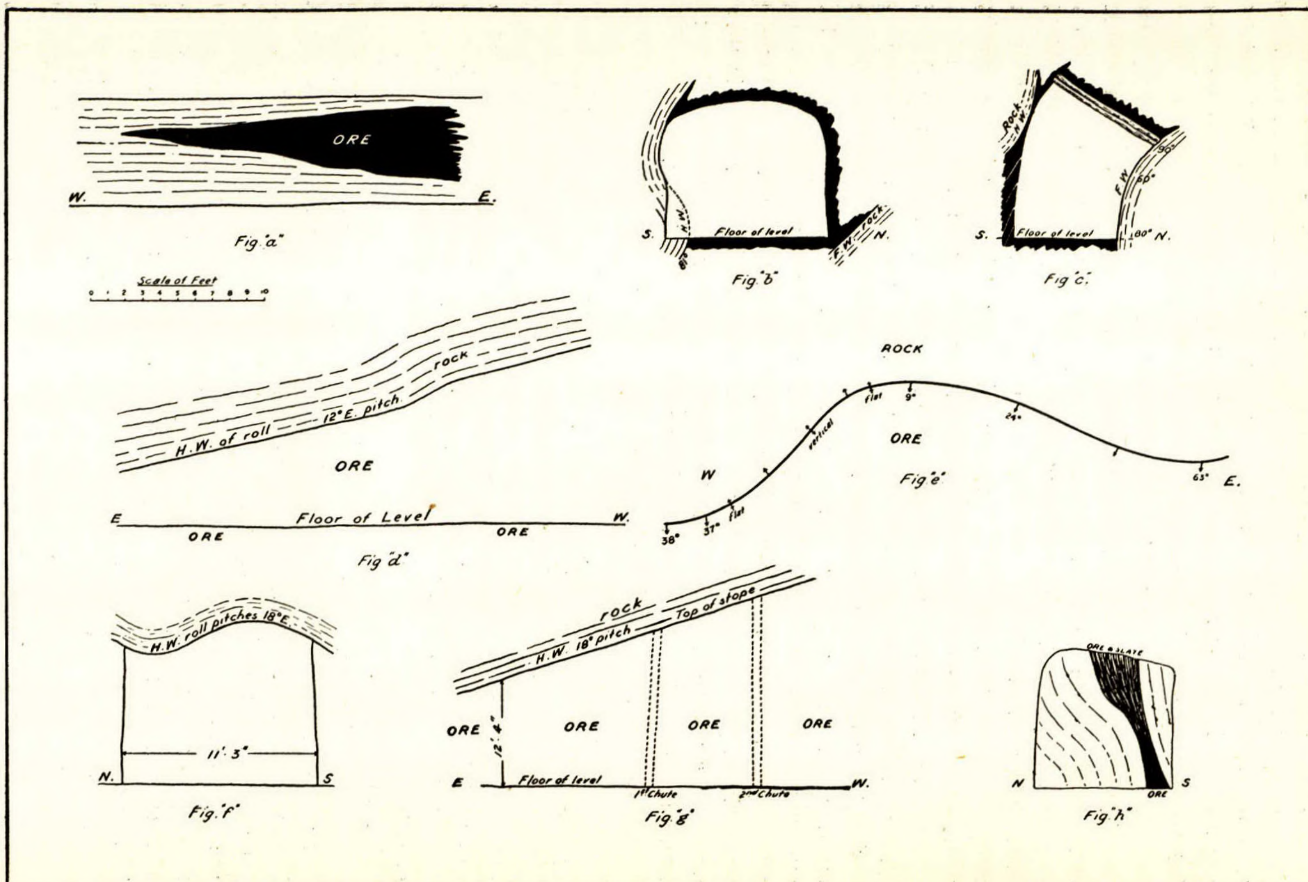
No. 1 *level: west.*—The west side of both levels is entirely in ore, which varies greatly in thickness. Description can be given only of the portions opened in the summer of 1906; whereas the map and profile, made in March, 1907, show more extensive development (Plates 26 and 28, fig. a.)

In No. 1 west level the ore rolls heavily, without pinching out. The changes in the hanging and the foot-wall show this well, illustrating the manner in which the folding progresses and the result in thickening the ore bed.

At the shaft the foot-wall dips 54°, as has been seen already. At twenty-seven feet west the foot-wall dip has declined to 45°. Meanwhile the hanging wall has increased from 79° to perpendicular, has become overturned to about 60° N., and has straightened out again to vertical. The ore here is eight feet on the floor and widening rapidly above; the main part of the roll, therefore, lies slightly above the level. At the first chute, 58 feet in, the dip is approximately 70° S.E. at the floor, in ore. At a height of six feet, however, the hanging wall is seen on the side of the level, changing from vertical above to 70° S.E. below and disappearing. The foot-wall has 80° S.E. dip at the floor, lowering to 60° and 40° upward. Thus at this point there is visible merely the bottom of the roll. At a point 37 feet in from the shaft the roll can be seen distinctly on the south side of the level, with an easterly pitch of 12°. Between the first chute and the second, 71 feet from the shaft, the pitch is 10°.

At the second chute the top of a second roll is met. On the floor the foot-wall is overturned to 88° N.; at five feet up it has returned to 72° S. The hanging wall comes in on the roof of the drift, between 12 and 13 feet above the floor, changing from low S.E. to flat and once more to low S.E. dip. The breadth occupied in this curving is 11 feet 3 inches. At 100 feet the main body of the roll is met. Simultaneously with the increase in thickness of the ore comes a slight left-hand turn, which persists beyond the end of the level as it was when inspected. At this 100 foot point the ore was 15 feet 3 inches broad when examined in the last of August, 1906, and no hanging wall seen. The foot-wall varied from vertical to 88° N. At 116 feet in the foot-wall lay at 57° S.E. dip, with no hanging wall visible, although a breadth of 18 feet 6 inches was stripped. At a distance of 144 feet from the shaft the bed takes a strong left-handed turn for a few feet. The foot-wall, as shown by the diagram, declines rapidly from 63° S.E. to horizontal

PLATE 29.



Structure sections in Wheelock Mine.

at the elbow of the turn, changing as the rocks curve to the left to a steep north dip, then flattens at the second elbow and returns to a moderate south-east dip once more. The type of change exhibited here is rather unusual, and has thus far not been found in any other part of the district. When examined, the level extended no farther, so that details of more recent work cannot be given here. Some of the structural features of this level are shown in Plate 29, figs. b to g, inclusive.

No. 1 level: east.—In this level ore rolls are succeeded by pinches. The hanging wall of the large roll described above as extending across the shaft strikes the floor of the level 65 feet east of the centre of the shaft. When seen first in the roof the hanging wall changes abruptly from a dip of 54° S.E. to 22° N.W. At 56 feet from the shaft the dip of the foot-wall has increased to 74° S.E. At 74 feet the ore pinches out in the roof, the hanging wall remaining steady, the foot-wall coming sharply south. Thence to 116 feet the level runs in rock. Over most of this barren distance the strike is N. 70° E. (magnetic), the dip about 82° S.E. At the end the ore comes in obliquely on the south side of the level, and evidently has not been pinched out for quite the whole rock interval indicated by the level. From this onward to the face, 226 feet from the shaft centre when examined, the dip varies from 73° to 79°. Here the foot-wall again comes in against the hanging wall, pinching the ore completely out in a second rock shoot. The iron has averaged seven to eight feet thick between the two rock masses. Plate 28, figs. c and d, and Plate 29, fig. h, show some of these features.

No. 2 level: west.—Of this level little can be said. It had been cut in ore throughout when examined, but was only 175 feet in from the shaft. The dip declines rapidly from the normal in going west, averaging 61° over much of the way to the first chute, where it is 54°. At 109 feet from the cross-cut it has become 47°, and at 134 feet is 34° on the foot-wall, flattening steadily to 150 feet from the shaft. The ore thickens here and a roll begins. The details could not be had when the examination was made, because of lack of development.

At the foot of the shaft a rock drift was started west on the strike, but carried only 10 feet. The rock is seen to roll heavily here, the dip being as low as 36° S.E. above and steepening rapidly downward. Eastward a rock level was run for 20 feet, and thence a cross-cut driven south to the ore. At the end of this rock level the roll is still felt, the dip changing from 33° S.E. at a height of 8 feet to 58° at the floor. In the south cross-cut the dip steepens rapidly to a maximum of 82° 30′ within six feet of the foot-wall of the ore. This cross-cut is 29 feet to the center of No. 2 level, and at its south end is 25 feet east of the shaft.

A cross-cut was also driven north for 135 feet. Details regarding it are not known, beyond the fact that the dips are uniformly steep and that the Leckie vein was cut.

No. 2 level: east.—From 10 or 15 feet east of the cross-cut westward, the ore in this level widens gradually, being 8.5 to 9 feet thick opposite the shaft and thicker to the west. At a distance of 79 feet 4 inches eastward from the cross-cut the ore pinches out, the line of pinch being vertical. The foot-wall dips 73° S.E. Both walls curve and converge, the hanging wall deviating most. The rocks as a whole take a left-hand turn, the strike swinging as far as to N. 10° E. (magnetic).

The ore begins to come in 55 feet farther east, the line of pinch having an eastward pitch of 76°, so that the rock is widening downward. This may also be seen by glancing at the two levels as drawn in longitudinal profile. The ore broadens very gradually and reaches a width of four feet in fifteen. The strike of the rocks is still abnormal—N. 37° E., dip 74° S.E. The south cross-cut is in rock, and shows the strata quickly swinging into a normal attitude—N. 55° E—the dip varying between 66° and 86°. At the time of inspection, the level had not encountered the ore in full width. Some details from this level are shown in Plate 28, figs. b, e and f, and Plate 29, fig. a.

Chemistry of the ore.—The following are the monthly averages at the Londonderry furnace. There are no sample analyses available, the exact location of which is known; and the monthly averages are in any event the most accurate general tests.

	Fe	Insol.	No.
First shipment	44.18	15.68	T-250
April, 1906	43.43	18.09	T-251
May	42.64	17.20	T-252
June	41.44	18.32	T-253
July	46.30	15.47	T-254
Aug.	41.71	19.30	T-255
Sept	39.85	19.23	T-256
Oct.	41.82	17.92	T-257
Nov	42.99	16.54	T-258
Dec.	43.10	16.86	T-259
Yearly average	42.74	17.46	T-97
" maximum	47.81	24.00	T-260
" minimum	36.12	13.50	T-261
1907			
Averages—			
Jan.	42.86	16.22	T-262
Feb.	45.30	16.94	T-263
March	43.20	17.43	T-264
April	44.83	16.20	T-265
May	46.76	15.19	T-98
Maximum—			
Jan.	45.60	19.80	T-266
Feb.	48.10	23.92	T-267
March	46.11	20.30	T-270
April	49.22	19.08	T-268
May	48.76	16.45	T-99
Minimum—			
Jan.	40.20	14.55	T-269
Feb.	40.10	13.58	T-271
March	40.73	13.57	T-272
April	41.73	14.62	T-273
May	43.46	13.22	T-100

A few Mines Branch samples follow:—

No. 1. Taken from train loading at Leckie mine, from teams. Ore came from stock pile and fresh cars from levels 1 and 2, and is good general run of ore in June, 1906.

No. 152. General sample from old dump.

No. 153. General sample from face in No. 1 level.

No. 154. General sample from face of No. 2 level.

No. 155. General sample from fresh dump; Nos. 152-155 in October, 1906.

	No. 1	No. 152	No. 153	No. 154	No. 155
Fe	40.52	45.620	47.360	42.41	40.90
SiO_2	....	10.980	9.000	....	....
Al_2O_3	....	7.020	6.600	....	....
CaO	....	8.620	8.730	....	....
MgO	....	.960	1.000	....	....
P	....	1.105	1.115	....	....
S	....	.305	.505	....	....

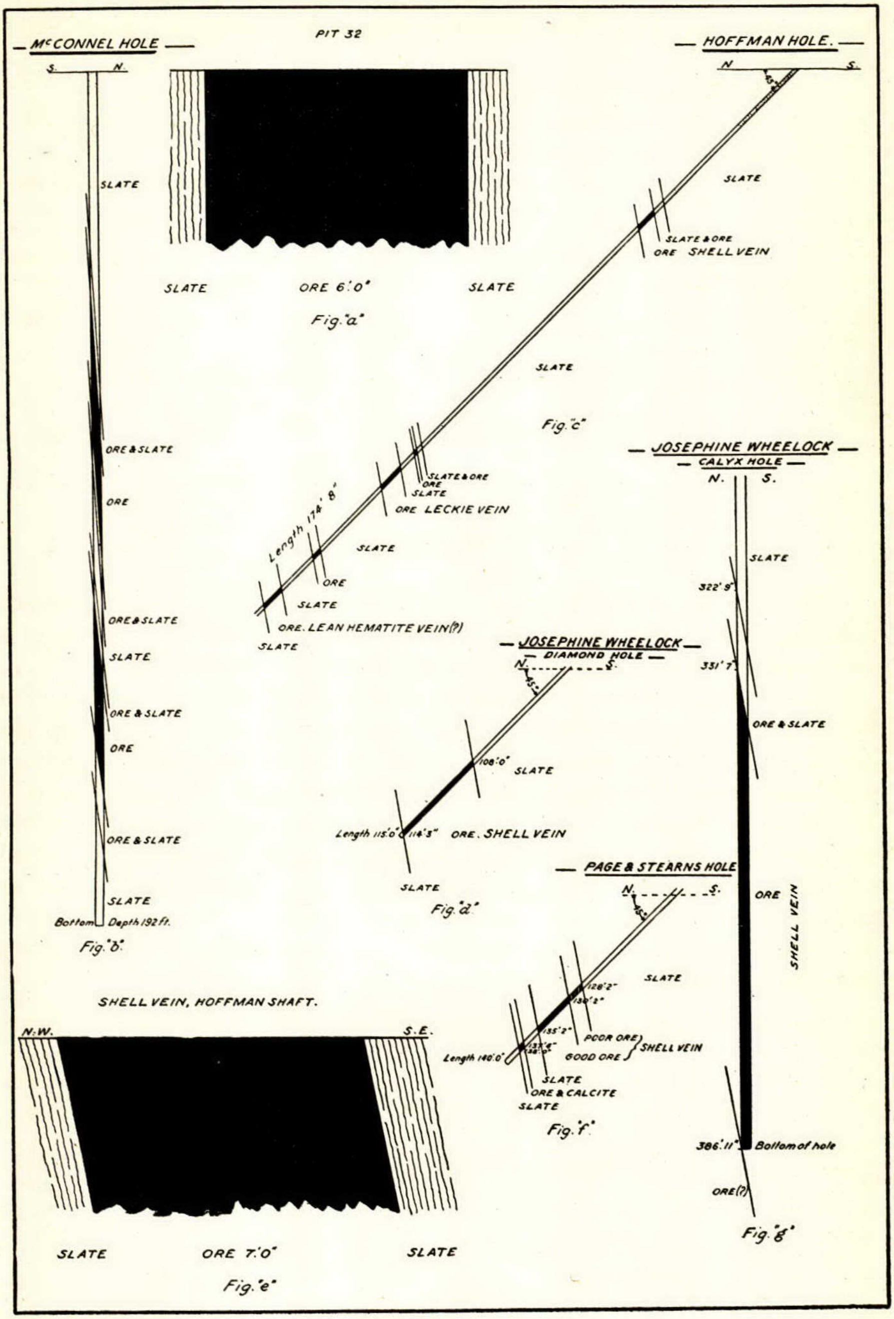
Boreholes.

Some of the boreholes in the Torbrook district have been mentioned, some have not. The log of each is given below, with such cognate data as are available. The numbers assigned are merely for convenience.

No. 1: Sam. McConnell property.—Unfortunately there is only one hole on the south side of the basin. This is on the corner of the McConnell property, 195 feet deep, made in 1901 by the Nova Scotian Mines Department with a 1,000 foot Davis calyx drill taking a 5 inch core. It is to be regretted that in strata dipping at such a high angle a Diamond drill was not oftener used, both by the provincial Mines Department and by individuals. At the surface the dip was 87° N.W.; at the bottom 83°. Very little of the core was to be found during the present study. The log below is from the original by Mr. James Phinney, drillman. A slightly different version is in N. S. Mines Dept. Rep. for 1901, page 74:—

Material.	Length, Feet	Total Length
Surface detritus	3	3
Loose dark blue slate, first distinct core	29	32
Broken blue slate	27	59
South side of core iron, north side slate	3	62
Black magnetite	30	92
South side of core slate, north side iron	8	100
Hard dark slate, almost black	30	130
South side of core iron, north side black slate	3	133
Black magnetite	33	166
South side of core slate, north side iron	6	172
Hard black slate	23	195

PLATE 30.



Sections of pits and drill holes.

Analysis of a highly vitreous appearing portion of the core, probably from near a wall (No. 35), gave Fe 38.52.

No. 2: Fletcher Wheelock property.—This was made in 1901 by the same drill. It is situated close to the road and south-east of a surface trench on the Shell bed. A summary is given in N. S. Mines Dept. Rep. for 1901, page 74. The dip at the surface was 84° S.E., decreasing to 70° at the bottom.

Material	Length, Feet	Total Length
Surface detritus	11	....
Broken red and blue shale	14	25
Red and blue shale	8	33
Blue shale with blotches of hematite	4	37
Red and gray shale, lower 10 feet with calcite seams	19	56
Blue and gray slate, calcite seams	50	106
Quartzite with calcite and pyrite	15	121
Magnetic brownish red hematite and quartzite, and calcite seams	13	134
Fossiliferous magnetic red hematite, some calcite	11	145
Ditto, with increasing amount of gray slate on north side	16	161
Dark red quartzite	4	165
Gray slate and quartzite, much broken	15	180
Gray and blue slate, lower part chiefly blue with some quartzite and pyrite	131	311
Red hematite	46	357
Red hematite and red and blue slate	16	373
Red and gray slate	10	383
Ditto, with streaks of hematite	14	397
Red shale and hematite	31	428
Blue slate	8	436
Blue slate and hematite	4	440
Red hematite	24	464
Red hematite, with red shale	3	467
Red hematite	4	471
Red hematite, with red shale	5	476
Red hematite and blue shale	6	482
Blue shale, lower part with calcite seams	79	561
Blue shale and quartzite	70	631

The core was so scattered that no proper inspection could be made. The character of the change of dip is therefore not known—whether regular, gradual, or sudden; whether persistent or spasmodic. The deficiency is regrettable, in view of the fact that this is the only source which might at present be available for determining the character of the syncline at this point. Attempt has been made by some to show, by means of the increase in thickness of the three ore beds in the core over that at or near the surface, that the beds were really broadening at a definite rate. But, bearing in mind the structure of the ore body as disclosed by the developments in the Wheelock mine, both the increase in thickness of the beds and their permanent decrease of dip appear problematical. For the enlargement of the ore in rolls and the non-synchronous changes of dip in the two walls can well explain the apparent conditions met in the drill-core. In view of the general tendency of bedded iron ore to maintain or vary its dimensions precisely like any sedimentary deposits, it is not to be expected that the iron in Torbrook will increase in thickness regularly downward.

No. 3: Josephine Wheelock estate.—On this property and 32 feet from its west line, 280 feet north of the Torbrook-Nictaux road and 17 feet south of the Shell bed, the same government drill was used in 1905 by the Nova Scotia Steel and Coal Company. Details from the original log are not available.

The summary in the N. S. Mines Dept. report for 1905 is as follows:—

Material	Thickness	Total length
Surface material	1′–6″	....
Bluish slates	321′–3″	322′–9″
Shaly hematite with shells	8′–10″	331′–7″
Red hematite (Shell bed)	55′–4″	386′–11″

The dip here is not given. Taken at the ore bed in a surface trench, it is 85° S.E. Much of the core was found. In most parts the stratification is parallel with the core, or vertical. The planes are extremely distinct, with much pyrite occurring in them. The bottom of the hole was still in ore.

No. 4: Josephine Wheelock estate.—This was made in 1906 by the Londonderry Iron and Mining Company, with a government 800-foot diamond drill taking a 15/16 inch core. It is situated about 260 feet north-west of the road, 80 feet south of the vein. Here again a detailed log is not available, and the summary below is from the N. S. Mines Dept. Report for 1906.

Material	Length	Total length
Surface material	12′–0″	....
Blue and gray slate	96′–0″	108′–0″
Red fossiliferous hematite (Shell bed)	6′–3″	114′–3″
Blue and gray slate	0′–9″	115′–0″

The hole was inclined 45° and the rock at the surface dips 80° S. E.

No. 5: Page and Stearns estate.—In 1906 a hole was put down upon the property locally long known by the above name, now held under the name of M. J. Taylor. It is situated 396 feet west of the east line of the property, and 42 feet south of the railway; and is inclined at 45°. The drill used was the same as in No. 4 hole. The work was done so late in the season that examination of the core was not possible; but the summary below is from the N. S. Mines Dept. report for 1906, p. 84. The rock at the surface dips 78° S. E.:—

Material	Thickness	Total length
Surface material	18′– 0″	....
Blue slate	4′– 3″	22′–3″
Gray slate	3′– 0″	25′–3″
Blue and gray slate	102′–11″	128′–2″
Shell bed, hematite, poor	2′– 0″	130′–2″
" " " good	5′– 0″	135′–2″
Gray slate	2′– 2″	137′–4″
Iron ore mixed with calcite	0′– 8″	138′–0″
Gray slate	2′– 0″	140′–0″

No. 6: Melville Hoffman property.—This was made by a government 400 foot hand diamond drill, taking a 1.1 inch core, put down in 1905 at an angle of 45°, to cut the Shell bed.

Material	Length	Total length
Surface material	18′– 0″	....
Grayish (fossiliferous) shales	20′– 0″	38′– 0″
Grayish (fossiliferous) shales, showing calcite	4′– 6″	42′– 6″
Mixed shales, hematite	2′– 5″	44′–11″
Red hematite	5′– 2″	50′– 1″
Dark blue and gray slates	70′– 5″	120′– 6″
Hematite and shales mixed	1′– 6″	122′– 0″
Red hematite	1′– 0″	123′– 0″
Dark shales	4′– 1″	127′– 1″
Red hematite	6′– 2″	133′– 3″
Gray shales	4′–11″	138′– 2″
Dark bluish shales	3′– 0″	141′– 2″
Dark bluish shales, with bands of ore	11′– 7″	152′– 9″
Light gray shales	0′– 9″	153′– 6″
Red hematite	2′– 6″	156′– 0″
Red and blue shales	10′– 4″	166′– 4″
Red hematite	5′– 6″	171′–10″
Bluish shale, with calcite	2′–10″	174′– 8″

Two holes were bored in 1905 on the J. Goucher farm, west of the Wheelock mine, with the government No. 3 steam diamond 400 foot drill. The records were so poorly kept as to be unreliable, and cannot be given here. Claim was made that iron giving 6 feet 5 inches on the incline (45°) was cut with its hanging wall at 183 feet depth on the incline.

No. 7: E. M. Barteaux property.—East of the Leckie mine and of the Torbrook-Wilmot road, three holes were sunk with the government No. 1 5 inch 1,000 foot calyx drill in 1900. One of these, located close to the road, did not reach undisturbed bed-rock.

Summary of its log is as follows:—

Material	Length	Total length
Loose detritus of clay and boulders	12′–0″	....
Reddish shale, soft and broken	48′–0″	60′–0″

No. 8: E. M. Barteaux property.—The two other holes were a few yards from the road, No. 9 opposite No. 7 and 15 feet east, No. 8 twelve feet south of No. 9. The dip of the rocks here is practically vertical, their strike N. 62° E. The following summary is taken from the log by Capt. J. Phinney, drillman, as is that of No. 9 hole.

Material	Length
Red shales	4′–0″
" and blue slate	63′–0″
Blue slate	19′–0″
Hard broken slates with quartz	13′–0″
Very hard blue slates and spar stringers	102′–0″
Total	201′–0″

No. 9: E. M. Barteaux property.—In the record of this borehole are several items of brown hematite. In view of the character of much of the iron and ferruginous rock to the east toward Black or Torbrook river, it is to be doubted whether more was found than discoloured ferruginous shale. If not this, the iron was probably in the form of thin irregular stringers, such as occur in places through the red rocks. The N. S. Mines Dept. Report for 1901 says (p. 73): "Through unfortunate locations, no vein was actually bored through, though excellent indications were shown by the cores."

Material	Length	Total length
Surface debris	13′–0″	....
Soft ferruginous red shale (should be designated slate)	13′–0″	26′–0″
Hard blue shale	3′–0″	29′–0″
Red shale with calcite, brown hematite	13′–0″	42′–0″
Hard blue and red shale and iron	14′–0″	56′–0″
Soft hematite and red shale	30′–0″	86′–0″
Hard hematite and shale	37′–0″	123′–0″
Red shale and hematite	27′–6″	150′–6″
Brown hematite and red shale, with calcite	11′–0″	161′–6″
Ditto, extra hard	3′–0″	164′–6″
Brown hematite and blue shale	46′–6″	211′–0″
" " " red shale	7′–0″	218′–0″
" " " blue shale	9′–0″	227′–0″
Light shale with calcite, rocks vertical	21′–0″	248′–0″
Light shale, dip 80°	5′–0″	253′–0″
Light shale, dip 82°	17′–0″	270′–0″
Light shale and brown ore	22′–0″	292′–0″
Blue shale and red quartzite	7′–0″	299′–0″
Light shale and calcite	4′–0″	303′–0″
Blue shale and quartzite	3′–0″	306′–0″
Ditto with calcite and sandstone	16′–0″	322′–0″
Quartzites, vertical	7′–0″	329′–0″

The hole is of special interest, although it exposes a small total thickness of rock, because it cuts the red strata, supposed, upon the theory of structure suggested in this paper, to underlie the productive iron-bearing formation of gray rocks. A long trench beside the road, on the west side of this same property, is said also to have cut only red rock.

No. 10: Leckie mine.—The remaining holes are by diamond drills, bored underground in the Leckie mine in search of the Shell bed or of the lost Leckie bed. Of some of these it has been possible for the author to examine the core.

No. 10 hole ran horizontally from the end of No. 5 east level, perpendicular to the strike of the strata, or about S. 25° E. Its length is 192 feet. The rocks cut are nearly vertical, or high south-east. Core measurements are as follows:—

Distance on core.	Rock.
0′–0″ to 1′– 1.5″	Slate
" 1′– 10″	Ore
" 2′– 2″	Slate.
" 2′– 3.5″	Ore
" 3′– 0″	Slate
" 3′– 2″	Ore
" 3′– 4″	Slate
" 3′– 9.75″	Ore
" 4′– 6″	Slate
" 4′– 8″	Ore
" 5′– 9″	Slate
" 5′– 11.6″	Ore
" 6′– 11.5″	Slate
" 7′– 4.5″	Ore
" 8′– 3.75″	Slate
" 8′– 5.5″	Ore
" 8′– 9.5″	Slate
" 9′– 4″	Ore
" 10′– 0″	Ore and slate
" 14′– 0″	Slate
" 16′– 0″	Ore
" 17′– 0″	Ore
" 17′– 10″	Ore and slate
" 19′– 0″	Slate
" 19′– 4″	Slate and ore
" 20′– 11″	Ore
" 21′– 9″	Slate
" 22′– 11.5″	Ore
" 23′– 2″	Slate
" 23′– 9″	Ore
" 24′– 2″	Ore and slate
" 25′– 10″	Ore
" 26′– 2″	Slate
" 29′– 9″	Ore
" 30′– 0″	Slate
" 30′– 8″	Ore
" 32′– 6″	No core
" 33′– 0″	Slate and ore
" 192′– 0″	Slate

This hole has great interest, as showing that below the pinch there is at the end east of the mine an imperfect concentration covering a great breadth. The iron is too poor to work but affords information as to the character of underground water action in disturbed ground.

No. 11: *Leckie mine.*—The second hole is from the end of No. 5 east level eastwardly, and at 45° inclination. The exact direction is not known.

Distance on core	Rock
0 to 54′–0″	mixed slate, calcareous rock and calcite
to 105′–0″	slate

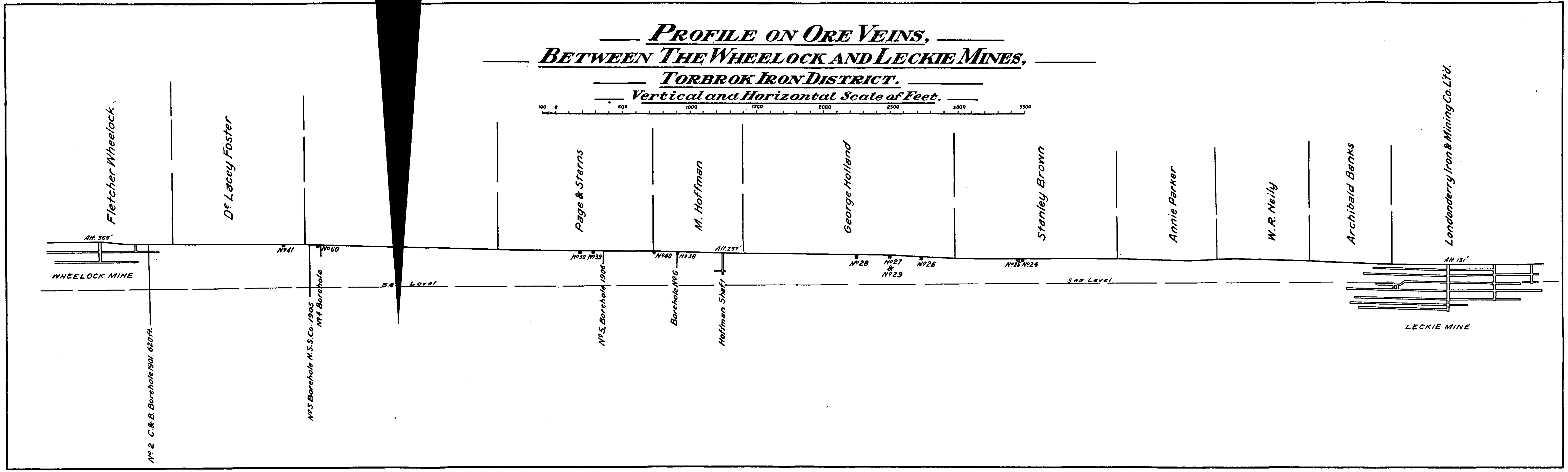
No. 12*: Leckie mine.*—Two holes were drilled from a point 162 feet in from the mouth of a cross-cut south-eastward from No. 3 level west of the Woodbury shaft. The first is 346 feet long, perpendicular to the strike and at an angle of 77° N. W. The core gave the following:—

Distance	Dip	Rock
1′–0″ to 3 feet	83° N.W.	Dark blue calcareous slates
" 5 "	80°	Light reddish green calcareous slates
" 10 "	80°	" " "
" 15 "	87°	" " "
" 20 "	88°	" " "
" 22 "	85°	" " "
" 23 "	80°	Light blue calcareous slates
" 27 "	80°	Light reddish green calcareous slates
" 30 "	80°	Dark blue calcareous slate
" 33 "	84°	" " "
" 34 "	80°	Light reddish green calcareous slate
" 35 "	80°	Dark blue calcareous slate
" 40 "	87°	" " "
" 45 "	90°	" " "
" 50 "	85°	" " "
" 55 "	83°	" " "
" 56 "		Pegmatite vein
" 75 "	80°	Dark calcareous slates
" 100 "	85°	" " "
" 150 "	83 aver.	" " "
" 155 "	85°	" " " with thin regular light bands to 230 ft.
" 160 "	84°	
" 165 "	83°	
" 170 "	81°	
" 175 "	85°	
" 180 "	82°	
" 185 "	85°	
" 190 "	84°	
" 195 "	85°	
" 196 "	86°	
" 205 "	84°	
" 210 "	85°	
" 215 "	86°	
" 225 "	83°	
" 230 "	86°	
" 237 "	86°	Pseudo-conglomerate, light quartz pebbles, slate matrix
" 245 "	86°	Dark blue slates with calcareous bands
" 250 "	87°	" " " "
" 255 "	86	Blue slates with frequent light irregular bands, brecciating the slate
" 267 "	84°	Ditto
" 270 "	84°	Dark blue slate with small regular calcareous bands
" 276 "	82°	Ditto
" 290 "	—	Diorite?
" 295 "	83°	Dark slate with narrow light bands
" 305 "	82°	" " " "
" 315 "	80°	Ditto, with some pseudo-conglomerate
" 320 "	75°	Ditto
" 325 "	80°	"
" 330 "	82°	"
" 340 "	75°	"
" 345 "	65°	"
" 346 "	66°	"

No. 13*: Leckie mine.*—A second hole was drilled from the same place as No. 12, but at an angle of 67° and for a length of 143 feet. The log is so monotonous as not to require setting forth in detail. For the first 20 feet are light gray and green slates with an average dip of 80° N. W. Thence to the end the rocks are dark blue calcareous slates, their dip fluctuating between vertical and 80° N. W., generally 85°.

No. 14: *Leckie mine.*—The last hole was bored horizontally from the end of the cross-cut south from No. 3 level, in 1906. The dips are north-west where not vertical.

Distance	Dip	Rocks
0′–0″ to 5′–0″	85° to 90°	Greasy slates, gray, greenish and reddish striped
" 10′–0″	90°	Ditto
" 12′–0″	"	Ditto, with small leaves of iron
" 14′–6″	"	Ditto, more compact, and with more gray
" 15′–0″	"	Light gray and green, with much iron
" 18′–0″	"	Dark gray slate, with iron stringers
" 20′–0″	75°	Light gray slate and gneiss, with iron stringers
" 27′–0″	75–90°	Ditto; nowhere more than ⅓ iron
" 32′–0″	75°	Light gray slate with light sandstone stringers and shells; little iron
" 33′–0″		Ditto; but no iron
" 35′–0″		Grades into light green and red slates
" 36′–0″		Ditto; with small amounts of coarse iron
" 40′–0″		Ditto; but no ore
" 45′–0″		Dark gray fine slate, with few iron stringers
" 47′–0″	70°	Ditto, with thin laminæ of red slate
" 55′–0″		Fine red, gray and green slate
" 57′–0″	80°	Ditto
" 60′–0″	65°	Ditto, with some dark gray slate
" 65′–0″	65–70°	Ditto
" 70′–0″	"	Chiefly light gray slate, with few red and green layers
" 75′–0″	80°	Ditto
" 80′–0″	75°	Ditto
" 83′–0″	"	Ditto, with few gray sandstone layers
" 85′–0″	"	Fine light gray and red greasy slate
" 90′–0″	"	Ditto, more sharply and regularly banded
" 96′–0″	"	Ditto, cleavage here as everywhere, about 85° N.
" 97′–0″	"	Light gray slate
" 105′–0″	"	As at 90–96 feet
" 110′–0″	"	No core, probably rock unchanged
" 113′–0″	"	Little core, ditto
" 115′–0″	"	Dark gray slate with iron stringers
" 120′–0″	60°	Ditto, becoming lighter
" 125′–0″	"	Still lighter, small irregular iron stringers
" 130′–0″	"	Lighter; much sandstone, blotches of iron
" 135′–0″	75°	Dark gray slate, small amount of iron in upper part
" 145′–0″		Ditto, few light sandstone layers
" 150′–0″	75–80°	Ditto, small amount of iron
" 160′–0″	"	Chiefly dark gray slate
" 165′–0″	80°	Ditto
" 175′–0″	"	Ditto, small amount of sandstone and iron
" 180′–0″	90°	Dark gray slate
" 185′–0″	80°	Gray, green and red slate
" 190′–0″		Ditto, but more siliceous
" 195′–0″		Dark gray slate, with few green and red streaks
" 202′–0″	75°	Dark gray slate, with coarse sandstone layers
" 205′–0″	70°	Dark gray slate
" 216′–0″	"	Ditto, with few light grey streaks
" 222′–0″	"	Light gray, green and red slate; little core
" 232′–0″	"	No core
" 235′–0″	55°	Light gray, green and red slate
" 243′–0″		Ditto, little core
" 245′–0″	50°	Dark striped gray slate
" 253′–9″	60°	Ditto, with few light grey and green layers


PROFILE ON ORE VEINS,
BETWEEN THE WHEELOCK AND LECKIE MINES,
TORBROK IRON DISTRICT.
Vertical and Horizontal Scale of Feet.
100 0 500 1000 1500 2000 2500 3000 3500
Fletcher Wheelock
Dr Lacey Foster
Page & Sterns
M. Hoffman
George Holland
Stanley Brown
Annie Parker
W. R. Neily
Archibald Banks
Londonderry Iron & Mining Co. Ltd.
Alt. 365'
WHEELOCK MINE
No 41
No 60
No 30
No 39
No 40
No 38
Alt. 237'
No 28
No 27
&
No 29
No 26
No 25
No 24
Alt. 131'
Sea Level
LECKIE MINE
No 2 C. & B. Borehole 1901. 620 ft.
No 3 Borehole N.S.S.Co. 1905
No 4 Borehole
No 5 Borehole 1906
Borehole No 6
Hoffman Shaft

The summary printed in the N. S. Mines Dept. Report for 1906, p. 83, is interesting for comparison.

Material	Distance	Total distance
Slate, bluish	15′–0″	15′–0″
Slate and iron, alternate bands	63′–9″	78′–9″
Slate, red, with bands of spar	36′–6″	115′–3″
Slate, bluish, with bands of iron	68′–0″	183′–3″
Slate, red	7′–9″	191′–0″
Slate, bluish	19′–3″	210′–3″
Slate, red	40′–0″	250′–3″
Slate, bluish	3′–6″	253′–9″

Interpretation of Structural Conditions.

Many of the data available in interpreting the structure of the district have been brought out in connexion with the various topics already discussed. Some others, such as the rock sections exhibited in the stream exposures, are far outside the scope of this study. It remains to note two points which may throw light upon the structure.

Leckie mine: cross-cuts.—A cross-cut north from No. 3 level, 240 feet north-west, is said to have passed through gray slates entirely, with steep south-east dip. In default of personal examination, which was not feasible, it can only be said that in the work of excavation it is at least possible that red and fawn-coloured slates, such as are known to lie south-east of the mine, might be overlooked by the observer.

The most important rock drift is the cross-cut south-east from No. 3 level. This runs 180 feet S. 16° W. The two inclined bore-holes already mentioned were started 162 feet in. The horizontal hole from the end gives a total horizontal section of 434 feet from the Leckie. At the hanging wall of the Leckie bed the dip is 50° S. E., thence decreasing steadily for 90 feet, where it is 0° (see Plate 25). The rocks pitch heavily south-west over part of this length, and at the axis the amount is 5° to 7°. This, however, is a small subordinate fold. After some undulation, as shown in the cross-section sketch, the axis of the main fold is reached at 114 feet from the mouth. South of this the rocks turn immediately to 67° N. W., within nine feet regaining their normal strike of N. 62° E. The dip increases rapidly to over 80°, and in parts is vertical. At the end it is 86° to 88° N., and the strike N. 80°–90° E. The axis of this syncline thus dips S. E. and pitches S. W. There seems to be no doubt of the reality of this fold, nor, judging from the dips and the rocks cut in the drifts and boreholes, does it appear to be merely a subsidiary crumple, but a fold of some magnitude and of a class likely to be accompanied by others co-ordinate with it.

Relation of syncline to Leckie ore body.—In the log of the horizontal borehole it will be noted that from 12 to 32 feet the rock is filled with thin leaves and stringers of iron, the individual bands rarely exceeding one-half inch in breadth but in places composing most of the rock. The situation of this ferruginous zone may correspond to that occupied by the Leckie ore bed on the north-west side of the syncline, but it is difficult to interpret the structure accurately enough to be sure. If this be correct, it is probable that the horizon occupied at the surface by the Leckie bed and squeezed out by the pinch at the bottom of the mine is to be found on the south side, but imperfectly replaced by iron. The absence of the light green talcose walls which bound the Leckie ore is unimportant, as their character is evidently secondary, and without the water-action which gave rise to the ore bed the wall rock would have no special distinguishing features.

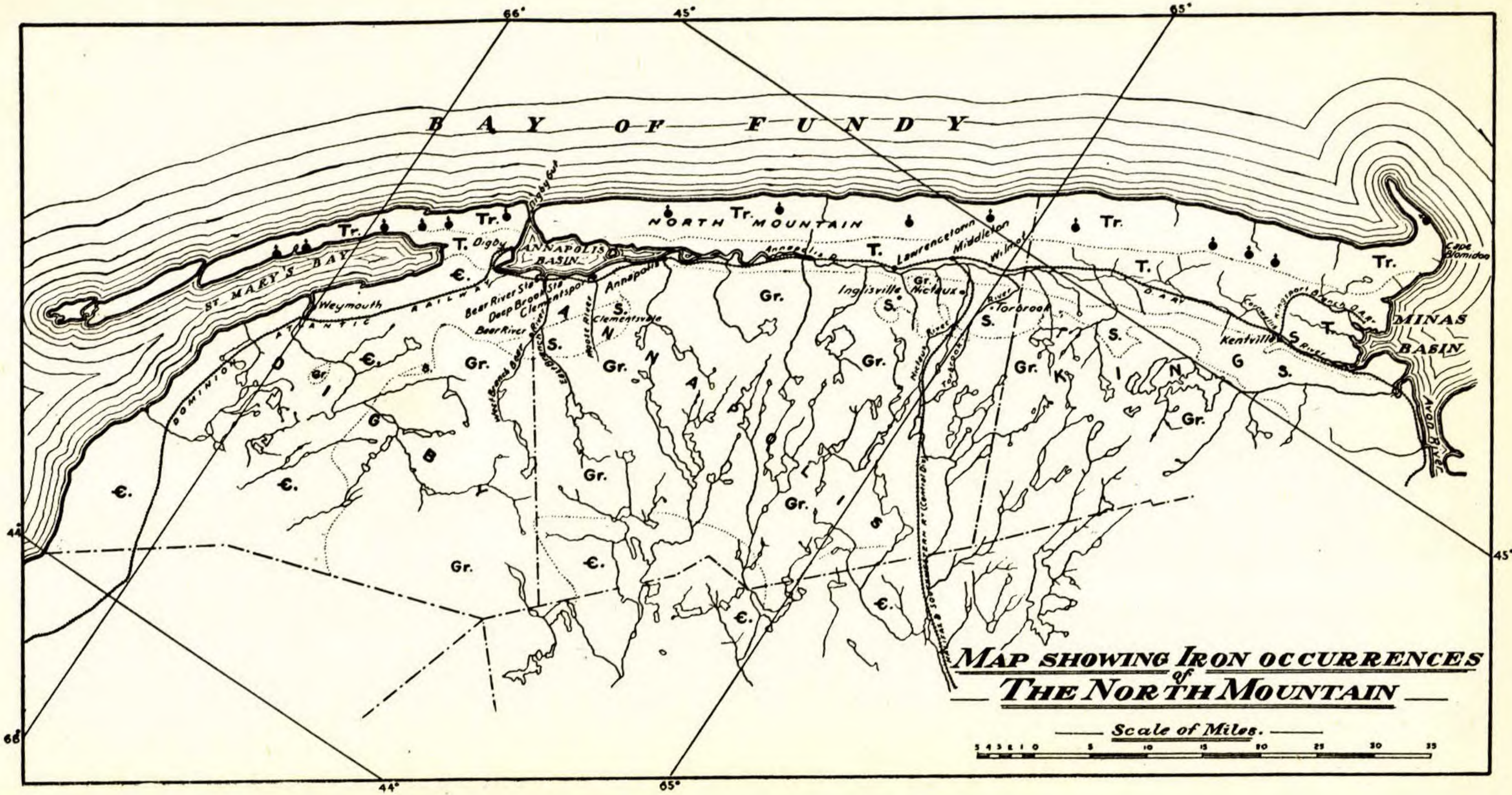
Moreover, there is reason from the structure as described to expect that the horizon of the Leckie ore will be found, much thickened, in the trough of the unsymmetrical syncline; and there is sufficient possibility of the rock being replaced by iron to warrant search by means of a diamond drill. Indeed, had the steeper of the two inclined holes in the cross-cut gone 150 feet farther, it would have penetrated the iron-bearing horizon. As it is, the attempt may be worth making from the surface, the total depth of such a hole being approximately 560 feet. A vertical hole of this depth, located 150 feet south-east of the Woodbury shaft, would be well situated for the purpose. This position is required by the dissymmetry of the fold.

Horizon of Shell vein.—Doubt has been expressed of the continuity of the rock and ore formations, because the Shell bed was not found in the cross-cut from No. 3 level. Calculation shows, however, that the horizon of the Shell bed would reach the axis of the syncline at a point higher than the altitude of the cross-cut, and would therefore not be intersected by it. Farther to the south-west the Shell vein would cross the axis at greater depth, because of the westward pitch.

Downward limit of Leckie ore.—Whether the axis of the syncline continues to pitch evenly throughout the district is to be doubted. It is to be remembered that the rolls and pinch in the Leckie mine pitch south-west, but that the rolls of the Wheelock mine pitch north-east. Since these structures are of the same dynamical nature as the folds, it is probable that the bottom of the syncline undulates. It would be unwise therefore, to attempt to compute the depth to which the ore of the Shell and Leckie beds should go at the Wheelock or Martin properties before rising on the south side of the fold.

The ore appears to be quite independent of present topography in its distribution. The Leckie mine shaft has an altitude of 136 feet, and the workings a depth of approximately 350 feet. The Wheelock shaft starts at an altitude of 370 feet, and the workings thus far go only 150 feet down. However, the Fletcher Wheelock borehole cut the Shell ore at an altitude of 253 to 215 feet, Leckie ore at an altitude of 35 to 1 foot, and the Lean Hematite vein at an altitude of minus 70 to minus 135 feet, the lowest point at which iron has been cut in that part of the district.

PLATE 32.


BAY OF FUNDY
NORTH MOUNTAIN
ST. MARY'S BAY
ANNAPOLIS BASIN
MINAS BASIN
Digby
Digby Gut
Weymouth
Bear River Sta.
Deep Brook Sta.
Clementsport
Clementsvale
Annapolis
Lawrencetown
Middleton
Wilmot
Inglisville
Nictaux
Torbrook
Kentville
Cape Blomidon
DIGBY
ANNAPOLIS
KINGS
66°
65°
45°
44°
MAP SHOWING IRON OCCURRENCES of THE NORTH MOUNTAIN
Scale of Miles.
5 4 3 2 1 0 5 10 15 20 25 30 35

CHAPTER 3.

IRON OF THE TRIASSIC TRAP.

CONTENTS OF CHAPTER 3.

Distribution and character.—The Triassic rocks of Nova Scotia occupy a long zone in the central and western part of the province. The area is bounded on the north by the Cobequid mountains, and on the south by the South mountain escarpment as far east as the Avon river, and by lowlands of Devonian and Carboniferous age thence eastward to the eastern terminus near Valley, ten miles east of Truro. Cobequid bay lies almost entirely within this Triassic area.

Volcanic trap occupies a portion of the western part of the region. On the south side of Cobequid bay and Bay of Fundy it lies as a long escarpment from Brier island to Cape Blomidon, steep toward the south and gentle in slope toward the bay on the north. On the north side of Cobequid bay are a number of isolated areas at or close to the shore.

In the various trap bodies on the north side of Cobequid bay are a number of irregular pockets of magnetite and magnetic hematite, up to a foot in breadth and of no considerable length. Gerrish mountain contains one, from which trial lots have been sent to Londonderry. In the North mountain trap, from Blomidon on the east to somewhat west of Digby on the west, are numerous pockets, all small and isolated, part magnetite and part specular hematite. Some of these are as follows, from east to west:—

(1) Outside of Blomidon, near Scotts Bay village.
(2) Vernon mines, north-west of Kentville.
(3) North-west of Lakeville.
(4) North of Berwick.
(5) Margaretville, north of Middleton
(6) South-west of Mount Hanly.
(7) Between Chute and Young coves.
(8) North of Annapolis.
(9) North of Digby.
(10) Rossway.
(11) Waterford.
(12) Moorehouse.
(13) Mink cove.

A number of analyses are available, of which the following will serve as illustrations. No 53 is a general sample of the surface of a 30-ton magnetite dump, Gerrish mountain; Tr–1 is an average of five analyses of magnetite from near Digby, from various published sources:—

	No. 53	Tr–1
Fe	56.09	58.820
SiO_2	17.18	10.880
Al_2O_3	.10	....
CaO	.35	....
MgO	2.02	....
P	.21	.041
S	.50	.034

Summary.—These are a few of the many small occurrences of magnetite and hematite in the Triassic trap. Others of the same class are undoubtedly present in large numbers, as indicated by the frequent finding of drift boulders of the ore on the mountain.

Thus far no veins have been discovered more than a foot in breadth, and none have shown a greater length than a few yards. No more than a few hundred tons of ore have been extracted from any one body, and this small amount has apparently involved the breaking down of considerable trap rock, and the expenditure of more money and labor than the ore was worth.

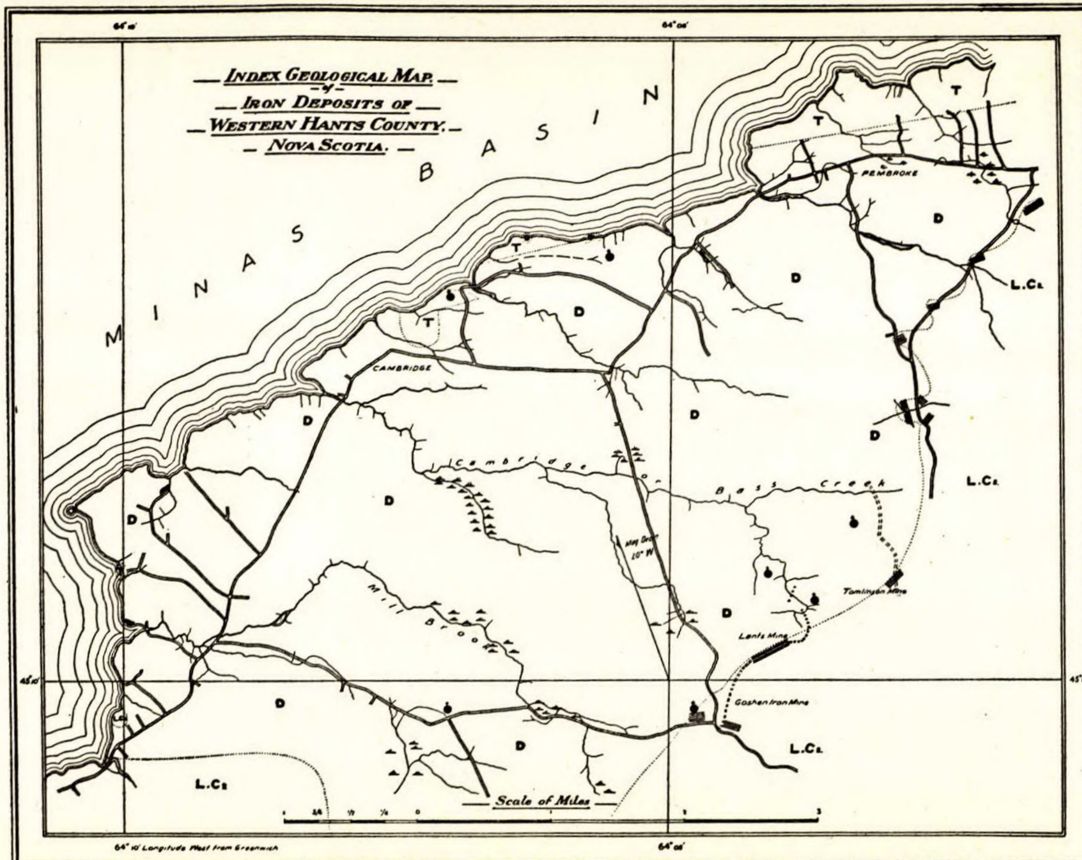
The probability of finding either magnetite or hematite in this trap in large bodies may be set down as *nil*. A considerable number of small, erratic and isolated veins take the place of a few larger masses. By virtue of the history through which the lava has passed, this is to be expected. The iron minerals are either original segregations during cooling, or secondary and in part amygdular fillings like the quartz, calcite and zeolites. As magnetite is often found disseminated in grains through the trap, and as it is an original accessory constituent of some igneous rocks, the former theory may at first sight appear the more probable. But the concentration into pockets and veins, at all events, is secondary, belonging to the same class of action as has brought about the gathering of the quartz, calcite and zeolite minerals; and probably all the iron in the trap has been introduced subsequent to the cooling of the lava.

As the trap presents no regular or extensive fissures or joint planes, and as it is not a rock easily replaced by the iron in solution, it follows that whatever iron is present lies in such irregular and closely localized cavities as it could find. Thus no expectation need be entertained that large bodies will be opened up.

These deposits have had little attention paid to them in the field during the season's work; and they would not be given prominence in this report were it not to complete the circuit of the country which might be made tributary to Annapolis or Parrsboro as a smelting centre, or to Acadia Mines, as is necessary under the present arrangement.

It is possible, despite the small size and scattered nature of these deposits, that at some time the largest and most accessible of them may be available for sale to a central smelter on a tonnage basis. All the occurrences of iron on North mountain are within reach of good roads, and some of them could have their contents shipped by water. Thus the most favored pockets or veins may yet contribute a few thousand tons to the iron industry of the country, adding to the income of the small local owner without requiring the investment of capital. But beyond this they cannot go, and there is no hope for any of them under the present market conditions.

PLATE 33.



(See Enlargement)

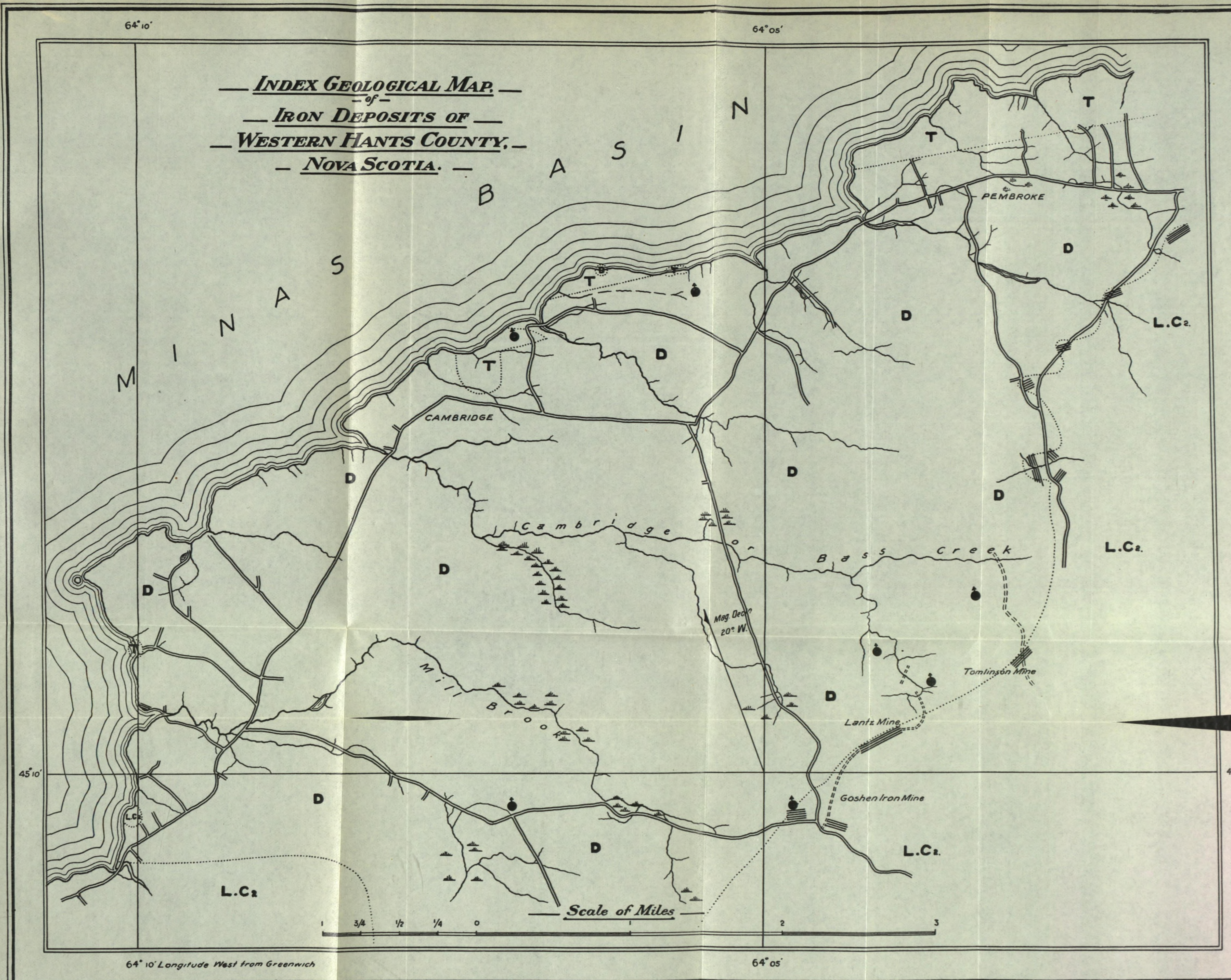
CHAPTER IV.

DEVONIAN DEPOSITS OF HANTS AND COLCHESTER COUNTIES.

CONTENTS OF CHAPTER 4.

Situation and general character.—From the Avon river north of Windsor, eastward through Hants and Colchester counties, the rocks at and near the contact of the Devonian and Carboniferous are the seat of various kinds of mineralization, especially limonite. In all except one or two instances the deposition has occurred in the Devonian. The upper rocks are, in the cases so far observed, the lower Carboniferous limestone or Windsor series.

Some of the iron localities are near either rail or water shipment, and the country is open. In most parts there is no good timber available, but others are well supplied. Water power is absent, and none of the occurrences of ore promise to be of sufficient size to make electric power installation an advantage.


INDEX GEOLOGICAL MAP.
of
IRON DEPOSITS OF
WESTERN HANTS COUNTY,
NOVA SCOTIA.
MINAS BASIN
64° 10'
64° 05'
45° 10'
45° 10'
PEMBROKE
CAMBRIDGE
Cambridge or Bass Creek
Mill Brook
Mag Decl.n 20° W.
Tomlinson Mine
Lantz Mine
Goshen Iron Mine
T
T
T
T
D
D
D
D
D
D
D
D
D
D
D
L.C2.
L.C2.
L.C2.
L.C2
L.C2
Scale of Miles
1
3/4
1/2
1/4
0
1
2
3
64° 10' Longitude West from Greenwich
64° 05'

Avon River to Tennycape.

In the territory covered by the Walton sheet (Geol. Surv. Can., doc. 879; Walton sheet, No. 74) are a number of occurrences of iron, some of which have been worked in a small way in the past (see Plate 33). From Tennycape westward, near and at the contact of the Devonian and the Windsor series, very many pockets of manganese ore (pyrolusite and occasionally manganite) are to be met. In parts, as at Noel, Tennycape and Walton, these are of a high degree of purity.

Lantz and Tomlinson openings.—Towards the south-west, at the Lantz and Tomlinson mines, the manganese is so mixed with iron as to become virtually a manganiferous iron ore.

These two mines, like the rest of those in Hants county, really prospects, are situated at the contact of the Devonian with the Windsor series on the south, lying in the former. The Lantz mine is one mile east of the Goshen road and four miles south-east of Cambridge. The Tomlinson mine is a mile farther east-north-east.

At the time of inspection the Lantz openings showed a few pits full of water, with no ore on the surface, hence no first-hand knowledge of the deposit was gained.

At the Tomlinson mine are a number of old and filled in shafts and pits, ore from two of which is to be seen on adjacent dumps. This ore is chiefly limonite, accompanied by crystalline quartz and pyrolusite (manganese). When worked, it was said to contain 6 to 12 per cent of the last. In the ore are brecciated fragments of a soft decayed rock resembling limestone. The productive belt has been reported to be six to eight feet wide at its best. At present there is no indication whatever of the character of the deposit or its size.

Goshen mine.—One mile south-west of the Lantz opening, on the Goshen road, is the Goshen mine; another contact deposit, on which some Windsor parties, about 1885, sunk a few shafts and ran levels. The claim was made that a large body had been found; but it seems not to have given such promise as would warrant continuing work. As the conditions of transportation and manufacture are changing, the time may come when it will pay to open up the mine once more.

In the report of the Department of Mines of Nova Scotia for 1874 occurs the following (p. 51):—"In the Goshen hills of Hants county a deposit of iron ore . . . has been opened up by Mr. Browne, and proved in one place to be forty feet wide. An adit has been begun that will intercept the lode at 85 feet from the surface."

At present nothing is in view except a pit and an old ore dump, exposing bottle limonite which much resembles the Londonderry ore, being in places formed around cores of ankerite or siderite. No outcrops are visible.

Analyses.—An analysis of this ore, which is limonite, and two analyses from the Mines Report for 1876, follow. Sample 160 was taken from one of the best dumps at the Tomlinson property, of fairly siliceous ore. Sample

161 came from an old dump at Goshen. The Goshen ore for the most part is heavy in manganese.

	1874 (D-1)	1876 (D-2)	1876 (D-3)	160	161
Fe	35.10	45.690	50.790	37.91	34.41
SiO_2	4.81	17.820	15.590	....	....
Al_2O_3	3.74	....	....	....	....
CaO	.35	....	....	....	....
MgO	4.76	....	....	....	....
MnO_2	24.74	.550	1.110	2.13	.66
P	.09	.035	.035	....	....
S	.08	....	....	....	....
Moisture	11.06	10.980	9.730	....	....

The ore analysed for the 1874 report was regarded as abnormal in its manganese contents.

Scattered occurrences.—At some other localities on this sheet, iron is reported. Thus there are traces on the shore three-fourths of a mile east of Cambridge, and on a creek to the eastward, between one and two miles west of Pembroke; but these have never been exploited. Sundry other locations are reported inland, but nothing can be learned about them.

Three samples, the first two from Mr. W. F. Jennison, marked "Cambridge," gave (Londonderry):—

	D-4	D-5	D-6
Fe	61.380	54.54	49.22
Insol.	....	9.00	9.00
P	.188	....	....

Nothing is known of the exact location or the method of sampling. All were hematites.

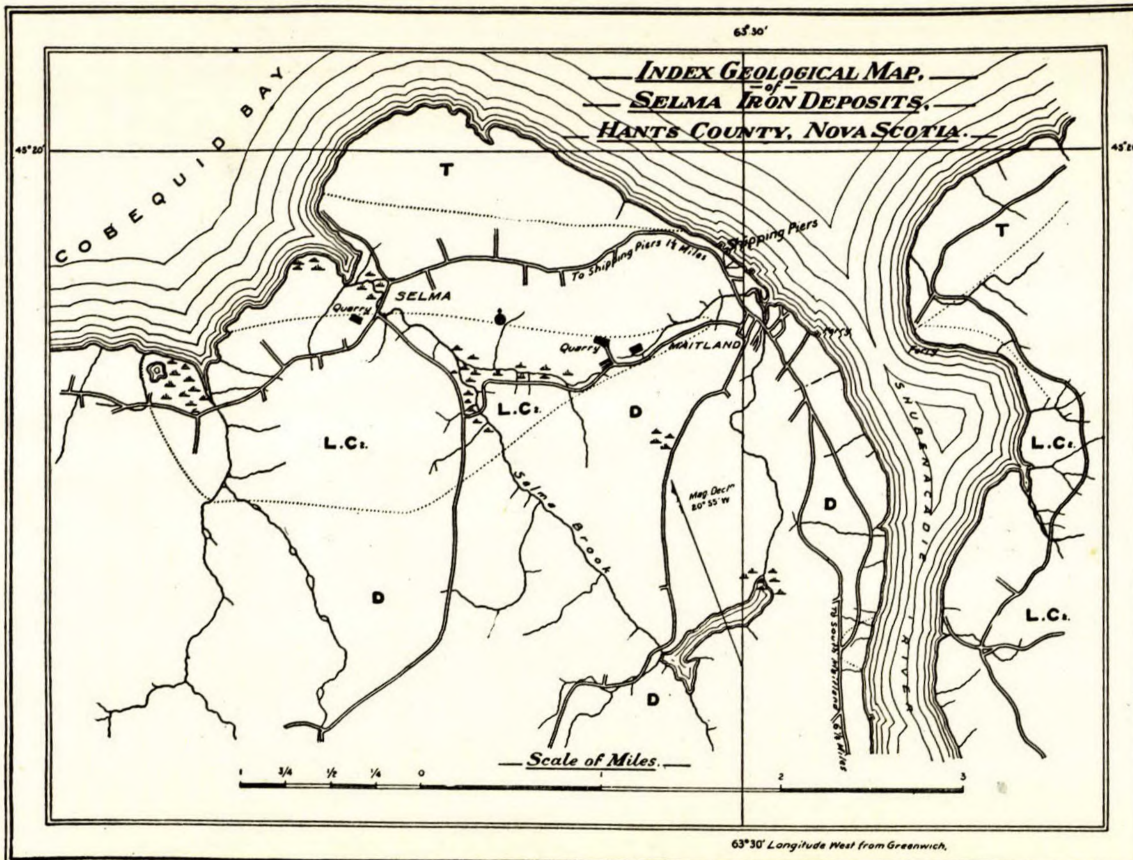
Summary.—The three openings mentioned earlier—Goshen, the Lantz, and the Tomlinson mines—are too far from any transportation to be of service unless the ore is of good grade and abundant. Cartage of at least ten miles would be required to land it at the nearest railway, which would be nearly 50 miles from Truro or 71 from the smelter at Acadia Mines.

The appearance of the ore and its distribution, as far as known, indicate that it belongs to the type of recurrent but isolated deposits common to contacts under certain circumstances, often very good in grade but most uncertain in amount and persistence.

SELMA.

Location.—Selma is situated west of the mouth of the Shubenacadie river, at the mouth of Rocky brook and three miles west of the village of Maitland (Plate 34). The nearest railroad station is South Maitland, seven miles by road to the south, on the Midland division of the Dominion Atlantic

PLATE 34.



INDEX GEOLOGICAL MAP, of SELMA IRON DEPOSITS, HANTS COUNTY, NOVA SCOTIA.
63°30'
45°20'
45°20'
COBEQUID BAY
T
SELMA
Quarry
Quarry
MAITLAND
To Shipping Piers 1¼ Miles
Shipping Piers
Ferry
Ferry
L.C2.
L.C2.
L.C2.
L.C2.
D
D
D
D
D
T
Selma Brook
Mag Decl.n 20° 55' W
To South Maitland 6½ Miles
SHUBENACADIE RIVER
Scale of Miles.
1 3/4 1/2 1/4 0 1 2 3
63°30' Longitude West from Greenwich.

railway. This station is 18 miles from Truro, or 39 from Acadia Mines by rail. The land is low, open and fertile. The village is practically on the shore of Cobequid bay, but shipping is not feasible there, even with costly wharfage. In the Shubenacadie river at Maitland shipping could be carried on intermittently when the tide permits. At Windsor a thousand tons of gypsum per day are shipped under no more favorable conditions. The rise of tide in the river at Maitland is 43 to 50 feet, and in the stream the depth at low tide is 9 feet. These remarks will apply as well to ore from Clifton, east of the river. (See also Geol. Surv. Can., doc. 837; Noel sheet 64.)

There are two pits or shafts, long disused, and several small openings. Both lie close to the contact between the Devonian and the Windsor series, being located in the former. No outcrops are to be seen.

Sweeney and Ells openings.—The pits lie on a line east–west (magnetic). At the western opening, on the property of Charles F. Ells, there is a dump of about 15 tons of a mixture of bottle limonite, the light variety mineralogically called goethite, and red and brownish hematite. The shaft is twelve feet deep, full of water.

The eastern or Sweeney pit, about 200 yards east of the former, shows a small dump of similar ore. Sample 157 is a general one from the dump of the first pit, 158 from the second.

	157	158
Fe	56.880	56.860
SiO_2	5.990	5.790
Al_2O_3	1.810	1.800
CaO	3.120	3.050
MgO	.200	.180
MnO_2	.480	.630
P	.055	.045
S.	.011	.012

The most important opening is on the farm of John and James Sweeney, now known as the Allan property, and a short distance south of the house. This property is bounded on the west by that of Charles F. Ells, on the east by that of John Scott, and on the north by that of John Sutherlands.

On the Sweeney farm the New Glasgow Iron, Coal and Railway Company, predecessor of the Nova Scotia Steel and Coal Company, sunk a small pit for eight feet. This showed clear ore in the bottom, a width of approximately eight feet, without finding any walls. The ore was part limonite, part red hematite, containing more of the latter than the former. An average analysis of the samples taken that time is below (D. 7). The second is from the Ells property, the third from the Sweeney farm, analyses made at Londonderry. The fifth is from the note-book of W. F. Jennison.

	D–7	D–8	D–9	D–10	D–11
Fe	44.00	50.00	56.50	46.020	62.810
SiO_2	10.00	8.72	5.80	12.610	4.900
P	.05	....	....	.037	.029
S.	very low	....	....	.020	.019

It is thus seen that the ore is promising, as it shows some body, but no exact limits are yet known.

Major R. G. E. Leckie subsequently made several openings on the Ells farm to the west, but found only mixed ore and rock; and it seems probable that the body does not extend in this direction. Exploration therefore should be directed to the Sweeney or Allan property especially.

Summary.—This deposit has in it more of promise than most of those near the contact of the Devonian and Windsor series, west of Brookfield, and is worthy of some attention. The haul to the station at South Maitland is ruinously long, and the freight charges over two railways would be high. But ore could be shipped from Maitland across to Great Village, near the lighthouse, with a two to three mile haul to the wharf, and about seven miles of carriage from a landing near Great Village to the furnace at Londonderry. Or shipment could as easily be made to Parrsboro, should a smelting centre ever be established there.

As the ore body is most probably a pocket, approximately at the contact, it is not likely that its tonnage will prove very great. Profit might be made by contract sale to the Londonderry Iron and Mining Company, even though the deposit proved to be insufficient for any other purpose.

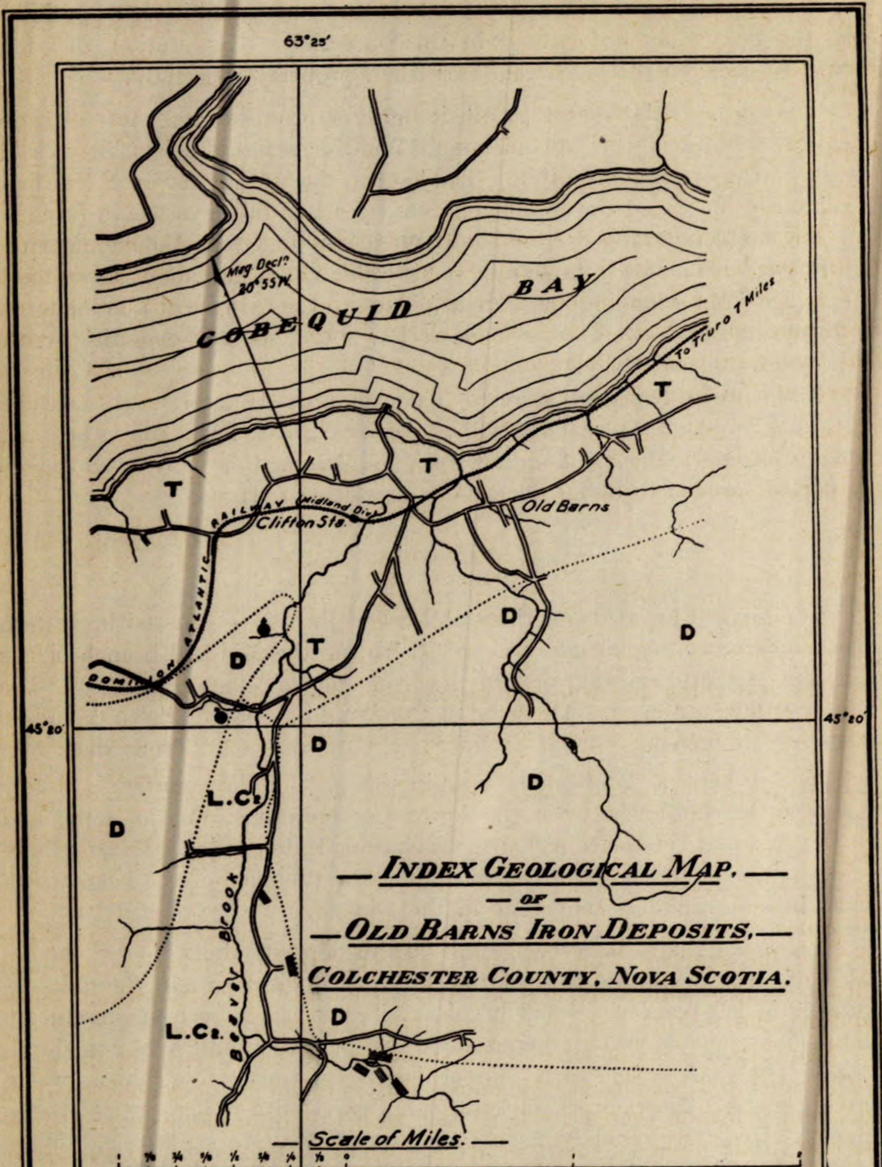
Clifton.

Situation.—Clifton, (sometimes called Old Barns), is situated in western Colchester county, seven miles west of Truro on the Midland branch of the Dominion Atlantic railway, or 28 miles from Acadia Mines (Plate 35). The country is low and open. The head of Cobequid bay lies a mile to the north of the iron occurrences. (See Geol. Surv. Can., doc. 636, Truro sheet 57.)

The ore here, as is often the case in this part of the country, is closely related to the contact between the lower Carboniferous Windsor series and the Devonian, at this place called the Mispec or Union series. Triassic rocks lie to the north, but have no bearing upon the presence of the iron, which occurs in a ferruginous sandstone in the Devonian.

Ore.—Two shafts have been sunk on this deposit, about 65 feet apart, and 4,500 feet below the fork of the Beaver brook road and the old post road, on the left bank of a small brook. All that can be seen at present are the openings, one a well timbered shaft full of water, and a 30 ton dump of ore. The shaft is said to be 70 feet deep. It is noticeable that no waste rock is present. No bedrock outcrops in the vicinity. The ore is chiefly limonite, often botryoidal, lying in concretionary form in sandstone. With it are red hematite, red ochre, goethite and some little earthy matter. From the ore body, which is said to be about six to seven feet thick, 497 tons were shipped to Londonderry about 30 years ago. Of this no analyses have been obtained, unless the following, marked "Truro: brown ore containing iron pyrite," be one (D. 12). The second analysis is from sample 156, a general test of the dump.

PLATE 35.


63°25'
Mag. Decl.n 20°55'W
COBEQUID
BAY
To Truro 7 Miles
T
T
T
T
RAILWAY (Midland Div.)
Clifton Sta.
Old Barns
ATLANTIC
DOMINION
D
D
D
D
D
D
D
45°20'
45°20'
L.C2
L.C2.
Beaver Brook
INDEX GEOLOGICAL MAP.
OF
OLD BARNS IRON DEPOSITS,
COLCHESTER COUNTY, NOVA SCOTIA.
Scale of Miles.
63°25' Longitude West from Greenwich.

	D–12	No. 156
Fe	46.350	55.770
SiO_2	17.000	9.960
Al_2O_3	4.210	1.810
CaO	.210	.400
MgO	.250	.220
MnO_2	trace..	.280
P	.141	.085
S	1.360	.016
Moisture	10.300	..

There is no means at present of determining the character or extent of the ore body; but it is doubtless a pocket, like others near the contact.

In 1903 the Londonderry Iron and Mining Company began to take ore from here on contract, but had to desist, owing to the quality. About 300 tons were used. Following are some of the analyses of the ore as mixed at the furnace:—

	D–13	D–14	D–15	D–16	D–17	D–18
Fe	34.240	32.130	28.76	39.00	58.60	39.00
SiO_2	45.570	49.680	54.46	38.17	7.70	......
MnO_2	.094	.107	....	....	....	......
P	.034	.023	....	....	....	......
S	.006	.009	....	....	....	......

The last three are from the west level. From the east level:—

	D–19	D–20	D–21
Fe	50.00	28.50	51.00
SiO_2	17.48	....	....

Some of these are marked "Clifton red". It is evident from the variability of the analyses that the iron ore, which is in kidneys, is not poor when free from sandstone, but is likely to be very impure without more handling and picking than is commercially feasible.

Shipping to Londonderry or Parrsboro would be difficult off the coast to the north, on account of the tides. But it might be accomplished from Lockherd point, on the east side of the mouth of the Shubenacadie river, westward four miles by road; or from a wharf which might be erected in the bend to the south of the other, at a shorter distance from the ore.

BROOKFIELD.

Situation.—The iron district of Brookfield, Colchester county, is three miles by road from Brookfield station, which is on the main line of the Intercolonial railway. The distance from this station to Londonderry station is 25 miles, or to Acadia Mines 28 miles. The country is for the most part open and the only bad grades are on a short stretch at the mine. Either a new road or a rail line could readily be built to Brookfield, and these grades avoided; indeed, there is already grading for a railway.

No water power of consequence is in the neighbourhood. Timber of small and medium size may be found in abundance near the mine. As there is no prospect for enough ore to require or permit local reduction, the question of electric smelting need not be considered.

Location of deposit.—Like the deposits above mentioned, the ore here lies in Devonian, which is represented in this district by the Union series, close to the contact of the lower Carboniferous limestone. This contact is somewhat sinuous, as shown upon the map (Plate 36). To the south of the ore-bearing rocks is a small valley, the mine openings being on the slope from the general plateau level down to the lower ground underlain by the limestone and gypsum.

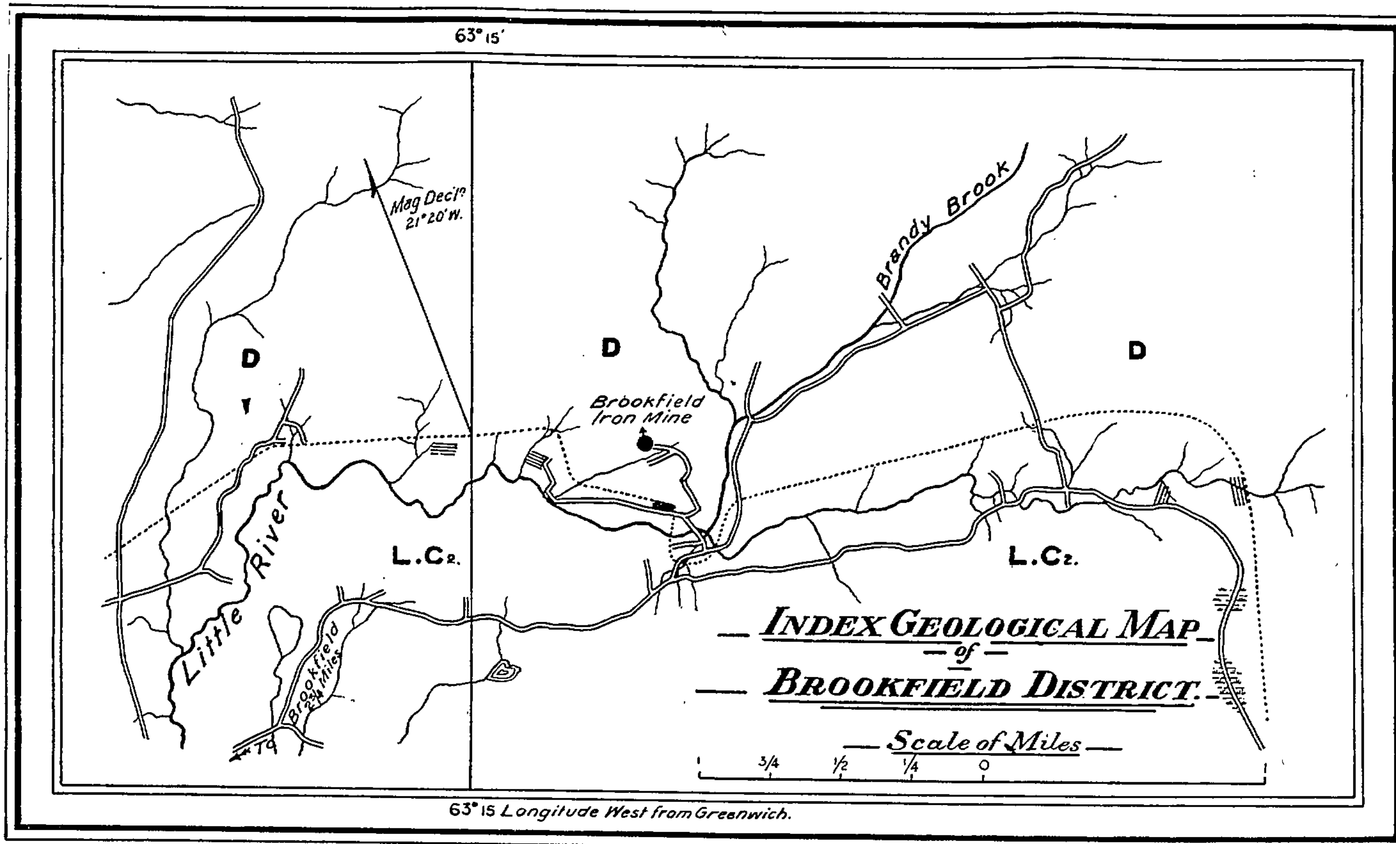
The Chambers mine.—The iron ore is of two classes. The first comprises that which occurs in the form of a lenticular pocket in a gash in red shales, which surround it on all sides. Immediately south of these is a massive quartzite. The longer direction of this pocket is roughly parallel with the contact and at a very oblique angle to the stratification, both in strike and dip. The size of the lode was roughly 300 feet long by 30 feet wide on the average. Some parts were as wide as 80 feet. The depth was variable, the shaft through the deposit being approximately 120 feet.

The ore was first opened in 1889 by Mr. R. E. Chambers, near the west side of the property of Leander Nelson, the ore being sold to the predecessors of the Londonderry Iron and Mining Company. Subsequently the property was sold to the New Glasgow Iron, Coal and Railway Company, predecessor of the Nova Scotia Steel and Coal Company.

In all, 44,400 tons of ore are recorded as having been extracted, the pocket being nearly exhausted. This does not, however, account for the size of the body as given above. The iron ore is in the form of limonite, the brown hematite of trade, sometimes massive, sometimes botryoidal. Apparently its value decreased rapidly towards the margins. Much of it as mined was mixed with considerable red clay, and during most of the time this was washed out before shipment. Some of the analyses show the need of this washing.

Analyses from Londonderry.—As this deposit is in quality quite typical of contact pocket lodes, analyses of it will be given in some fullness; the more particularly because the Pictou county contact deposits are not described in this volume. The first lot of analyses are from the books of the Londonderry Iron and Mining Company. All are from carload lots and many are averages of several. Those deserving especial mention are:—No. 24, three lots; 26, three lots; 27, five lots; 28, twelve lots; 30, fourteen lots, fortnightly averages; 32, six lots; 33, six lots; 34, fourteen lots. Being working analyses, these have a distinct advantage over either sample or specimen assays.

PLATE 36.



63° 15'
Mag Decl.n 21° 20' W.
D
D
D
Brandy Brook
Brookfield Iron Mine
Little River
L.C2.
L.C2.
Brookfield 2¼ Miles
INDEX GEOLOGICAL MAP of BROOKFIELD DISTRICT.
Scale of Miles
3/4
1/2
1/4
0
63° 15 Longitude West from Greenwich.

No. DB–	Fe	SiO_2	Insol.	CaO	MgO	MnO_2	P	vol. matter
1	46.34	17.08	....	.21	.25	trace	.065	....
2	53.04	....	11.46	....	....	....	....	....
3	50.39	....	11.80	....	....	....	....	....
4	46.37	22.00	....	....	....	....	....	....
5	45.68	23.90	....	....	....	....	....	....
6	42.43	17.10	....	....	....	6.51	....	15.70
7	28.29	4.30	....	14.78	....	8.46	....	26.00
8	48.30	20.70	....	....	....	....	....	....
9	50.02	17.00	....	....	....	....	....	....
10	45.81	24.00	....	....	....	....	....	....
11	44.70	22.20	....	....	....	....	....	....
12	45.17	24.30	....	....	....	....	....	....
13	45.07	23.60	....	....	....	....	....	....
14	44.34	23.20	....	....	....	....	....	....
15	52.83	12.50	....	....	....	....	....	....
16	49.88	18.50	....	....	....	....	....	....
17	42.86	27.20	....	....	....	....	....	....
18	46.74	19.80	....	....	....	....	....	....
19	39.36	33.59	....	....	....	....	....	....
20	35.47	37.70	....	....	....	....	....	....
21	41.00	27.62	....	....	....	....	....	....
22	46.18	27.60	....	....	....	....	....	....
23	42.89	26.40	....	....	....	....	....	....
24	49.80	trace	....	....	....	....	....	....
25	31.70	41.80	....	....	....	....	....	....
26	36.50	37.80	....	....	....	....	....	....
27	36.90	36.40	....	....	....	....	....	....
28	49.50	13.40	....	....	....	....	....	....
29	49.50	10.50	....	....	....	....	....	....
30	41.75	26.90	....	....	....	....	....	....
31	32.51	42.70	....	....	....	....	....	....
32	35.47	38.00	....	....	....	....	....	....
33	47.76	19.90	....	....	....	....	....	....
34	51.36	12.10	....	....	....	....	....	....
35	40.76	28.90	....	....	....	....	....	....
36	46.08	22.20	....	....	....	....	....	....
37	42.54	22.60	....	....	....	....	....	....
38	38.64	26.20	....	....	....	....	....	....
39	40.16	29.30	....	....	....	....	....	....

Unfortunately, few of these analyses give more than two ingredients. They show, however, a moderate iron content and high silica; the latter due in part, no doubt, to admixture of shale. There is some manganese, and this is rather characteristic of the district.

Analyses from Nova Scotia Steel and Coal Company.—From the books of the Nova Scotia Steel and Coal Company are taken the following analyses:—

No.	Fe	SiO_2	Insol.	MnO_2	Moisture & organ. mat.	P
D B—40	54.16	2.80	....	....	17.64	.040
" 41	53.40	....	10.80	....	....	....
" 42	43.80	....	25.40	....	....	....
" 43	46.00	....	17.72	....	....	....
" 44	48.15	....	16.82	....	....	(.029 $BaSO_4$)
" 45	52.29	....	14.00	10.48	....	....
" 46	48.60	....	16.88	.50	....	.007
" 47	48.80	....	14.48	.40	....	.037
" 48	46.46	....	18.64	....	12.50	....
" 49	44.72	....	....	1.30	....	....
" 50	45.09	....	....	....	....	....

No. 40 is above the average, which may be taken as shown in 41, 42, 43, 44 and 45 for the main part of the pocket during the time the ore was shipped to the furnace of the Steel company at Ferrona. No. 40 came from the north level, and 47 from the bottom of the shaft. No. 48 is an average of five cars; and it and the two following are especially low, taken at the end of 1901, when the pocket was becoming exhausted and the wall ore was being taken.

Recent openings.—The more recent developments in Brookfield, upon partially bedded spathic limonite south of the pocket, will be considered in detail in the second volume.

CHAPTER V.

ORES OF THE WESTERN COBEQUIDS.

CONTENTS OF CHAPTER 5.

The Cobequid Mountains.

Distribution and general composition.—The Cobequid mountains proper form a topographic and geologic unit in the northern part of Nova Scotia, extending throughout the breadth of Cumberland and Colchester counties eastward into Pictou county. At a short distance west of the Pictou coal field the range becomes locally interrupted, and eastward from there its character changes somewhat; but within the limits of the present discussion it is extremely uniform in topography, composition and structure.

Its centre or protaxis consists of a series of acid (siliceous) igneous rocks of various kinds. As these are not at present known to carry workable ore bodies, they will not be referred to further. Flanking this core are sedimentary strata of Silurian, Devonian and Carboniferous age. The two former ante-date the igneous rocks and are invaded and often highly metamorphosed by them. On the south side of the range, in Cumberland and Colchester counties, the Devonian lies directly against the protaxis, striking roughly east-west with the range and dipping now north, now south, usually at high angles. This series contains the iron ores. Against the mountain mass lie rocks of the lower Carboniferous, unconformably upon the Devonian, and, with the Triassic of the Bay of Fundy, forming the great lowland to the south of the Cobequids. Neither of these last series carries iron, so far as now known.

Accessibility of iron-bearing zone.—The crest of the range is from 700 to 1,000 feet in altitude. The zone along which the iron ore is found is much lower, rarely over 500 feet; and its southern side is approximately at the level at which many of the farm clearings begin. Below the iron ore belt a base line road runs east from Lornevale for about nine miles to East Mines, parallel with the general strike of the ore zone. All of the iron ore openings so far made are easily accessible to transportation, and many portions of the country in which prospecting may later prove worth while can be reached without difficulty.

Transportation.—The ore belt is crossed by the main line of the Intercolonial railway on its course from Truro across the mountains. From Truro the road makes a long turn westward to Londonderry station, apparently expressly to accommodate the iron interests. Thence a turn is made again eastward to the valley of Folly (or Folleigh) river before ascending to the crest of the range, on the way to the north country. From the main line a spur line of standard gauge runs from East Mines station to East Mines, and from Londonderry station to Acadia Mines, about three miles in each case. From the village at Acadia Mines a narrow gauge track runs west as far as Cumberland brook, the seat of the westernmost workings.

The country as far east as Debert river at least, and as far west as the Portapique, is all easily made tributary to Acadia Mines by extensions of present railways.

A line has been surveyed from Parrsboro to Truro, and spurs from this would bring within reach any iron ore deposits opened up between Parrsboro and the Portapique river. West of Parrsboro transportation becomes a more difficult problem, and might have to be by water.

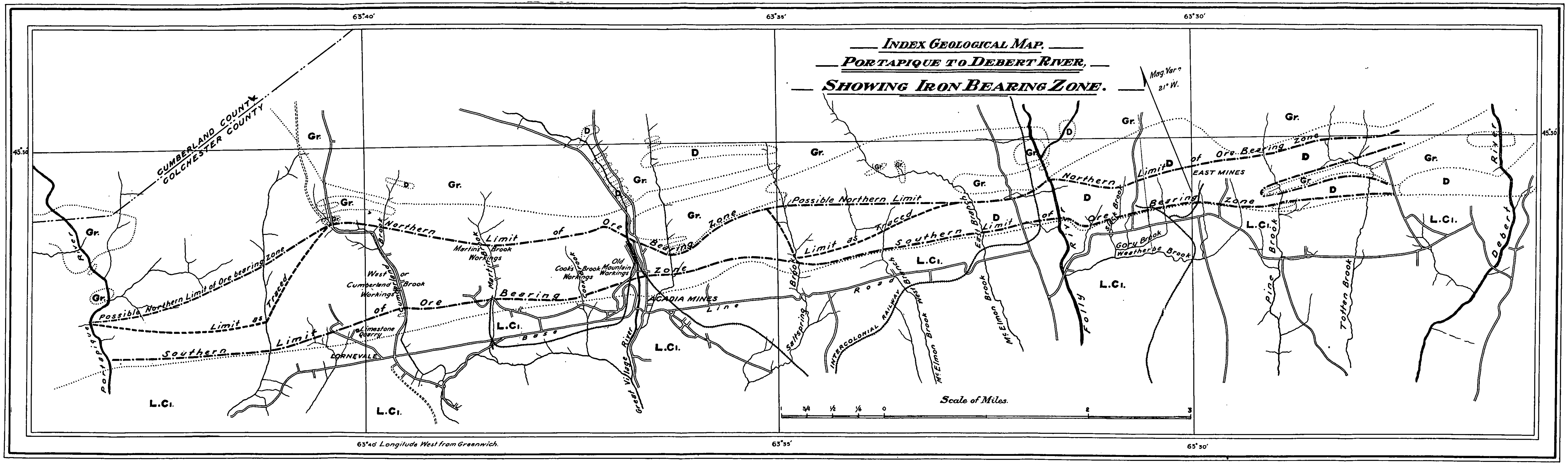
Power.—The Cobequid range abounds in streams, many of them of good size in any but dry seasons of the year. But very few have sufficient body during the summer for power purposes, largely owing to the absence of reservoir lakes near the headwaters. In certain cases artificial storage could be resorted to with some success, because of the gorge-like shape of the valley at favorable points. Any of the streams which might be used for electric power would require this; and even with this precaution there are few which could be depended upon. Debert river on the east and Folly river near the Intercolonial railway could in this way be made to yield tolerably large power. No stream to the west is adequate until Portapique river is reached, nine and one-half miles away and at the western boundary of the Londonderry Iron and Mining Company's property. From here westward a number of streams are available, but as iron ore is not known in quantities which would warrant present expectation of large local works, they need receive no notice at present.

Timber.—The parts of the Cobequid mountains which lie near to cultivation have only culled wood growth. But further north, at the centre of the upland, the timber is more abundant and heavier. Not only is there a supply sufficient for any mining which may be attempted, but, according to the ranger of the Londonderry company, there is enough for any electric smelting which may at any time be carried on. He states that at least 18,000 acres of the company's land are covered with a good growth, 40 per cent of which is hardwood, chiefly beech, birch and maple. The company controls but a small percentage of the full expanse of woodland on the mountain range. The Cobequid mountains and other parts of Cumberland county to the north furnish some of the best wood now to be had in the province.

The Iron.

Distribution and classification.—The iron ore found on the south of the Cobequids is widely distributed, both geologically and geographically. It extends from Advocate bay on the west intermittently to the eastern boundary of the survey and beyond; and from the shore of Cobequid bay on the south to the igneous rocks of the mountain axis on the north. As yet, iron ore is not known to occur in the latter except in a few small contact bodies; but many isolated veins lie near it in the Devonian, even where the zone occupied by the latter is wide.

Geologically the ore may be rather arbitrarily divided into four groups: —(1) pockets in the Triassic trap near Cobequid bay; (2) scattered occurrences in the Devonian, apparently unrelated to the lower Carboniferous contact or, perhaps, to any widespread structure, although in places aligned in east and west zones and in others located near igneous contacts; (3) veins in close proximity to igneous contacts of the Devonian and granites or within the latter rocks, in part highly siliceous and massive and in part


INDEX GEOLOGICAL MAP,
PORTAPIQUE TO DEBERT RIVER,
SHOWING IRON BEARING ZONE.
Mag. Varn 21° W.
63°40'
63°35'
63°30'
45.30
CUMBERLAND COUNTY
COLCHESTER COUNTY
Possible Northern Limit of Ore bearing Zone
Limit as Traced
Southern Limit
Northern Limit of Ore Bearing Zone
Possible Northern Limit
Limit as Traced Southern Limit of Ore Bearing Zone
Northern Limit of Ore Bearing Zone
EAST MINES
ACADIA MINES
LORNEVALE
Limestone Quarry
West or Cumberland Brook Workings
Martins Brook Workings
Cooks Brook Workings
Old Mountain Workings
Base Line
Road
INTERCOLONIAL RAILWAY
Portapique River
Great Village River
Saltspring Brook
West Branch
East Branch
McElmon Brook
Folly River
Gory Brook
Weatherbe Brook
Pine Brook
Totten Brook
Debert River
L.Cl.
Gr.
D
Scale of Miles.
1 3/4 1/2 1/4 0 2 3
63°40' Longitude West from Greenwich.
63°35'
63°30'

specular and affected by or dependent upon this proximity; and (4) ore bodies occupying a long and narrow zone in the Devonian, in a general way following its contact with the lower Carboniferous to the south, but not dependent upon it. The last is the most important.

Scattered occurrences within the Devonian.—Of isolated exposures of iron ores in Devonian rocks, coming under group 2, many are known. While small and usually irregularly distributed, in certain instances they seem to be oriented along one or more east-west lines. In addition they are associated with certain strata which are strikingly similar to those accompanying the ore at Acadia Mines. As will be seen in the sequel, there is every reason to believe that the latter veins extend, perhaps intermittently and to varying extents, far west of the westernmost present workings.

Iron near Carboniferous contact.—By far the most important class of deposits, so far as its past history and present value are concerned, is the last. It embraces a considerable variety of ores and covers a great extent of country.

Although probably but a continuation eastward of the zone which contains the deposits of group 2, its importance and the detail of our knowledge concerning it demand that it be given separate treatment.

The Londonderry Range.—(1) To Portapique River.

Distribution and cross-section.—From a point midway between Bass river of Five Islands and East river of Five Islands, a band of the lower Carboniferous conglomerate formation stretches eastward without interruption for 42 miles to a point south of McKenzie settlement. Thence eastward toward the southern side of the Pictou coal field it occurs in isolated patches only. Throughout the western two-thirds of its length this zone is bounded on the south by Triassic strata, which are followed by Devonian from Debert river east. Devonian lies to the north at all points.

A north-south section on any line east of East river of Five Islands would give in general the following:—(1) at the north the protaxis of intrusive rocks, showing igneous contacts with the next rocks south, and profoundly altering the nearest of them; (2) a zone of Devonian strata of variable width; (3) above an unconformable contact, the lower Carboniferous, with different and far less altered sediments; (4) above another unconformable contact, the Triassic. With the first and the last two we have no further concern in this connection, except as two of them bound and limit the iron-bearing beds.

Zone of Devonian strata.—From the west the Devonian between the Carboniferous and igneous rocks forms but a narrow zone, for the most part only a fraction of a mile in width, as far east as the Portapique river. Northward comes an area occupied by igneous rocks from one to three miles wide, followed by a great development of the Devonian sediments. So far as known no exploratory work for iron has been done in this northern area.

On the upper Portapique river iron is marked on the Geological Survey map (doc. 836; Londonderry sheet, No. 63), but the present author has no knowledge of its character. This is the only occurrence noted.

The strike of the Devonian in the zone which carries the Londonderry ore is nearly east and west in most places. The dips are both north and south; and other additional evidence leads to the belief that the strata are probably folded once or more, and that the same beds will be found outcropping in two or more zones. This requires proof in the field; but it is an important point, for the presence of the iron appears to depend upon both a favorable zone of fissures and a favorable series of strata which can in part be replaced by ore. Fissures are certainly abundant, and a repetition of favorable beds would give far greater probability of recurrence of the ore in more than one zone.

From the Portapique to the Debert river the Devonian band is more irregular in breadth, but even there rarely more than one and one-half miles across. Beyond the Debert river the present study does not go.

The iron minerals found in the strata in this zone are similar to those westward. The most important are siderite, ankerite, both mixed with calcite in places; limonite in one of its several forms of paint or ochre, massive, cellular, fibrous, and bottle or botryoidal; also the hydrous minerals goethite and turgite, which for present purposes may be classed the one as limonite and the other as hematite.

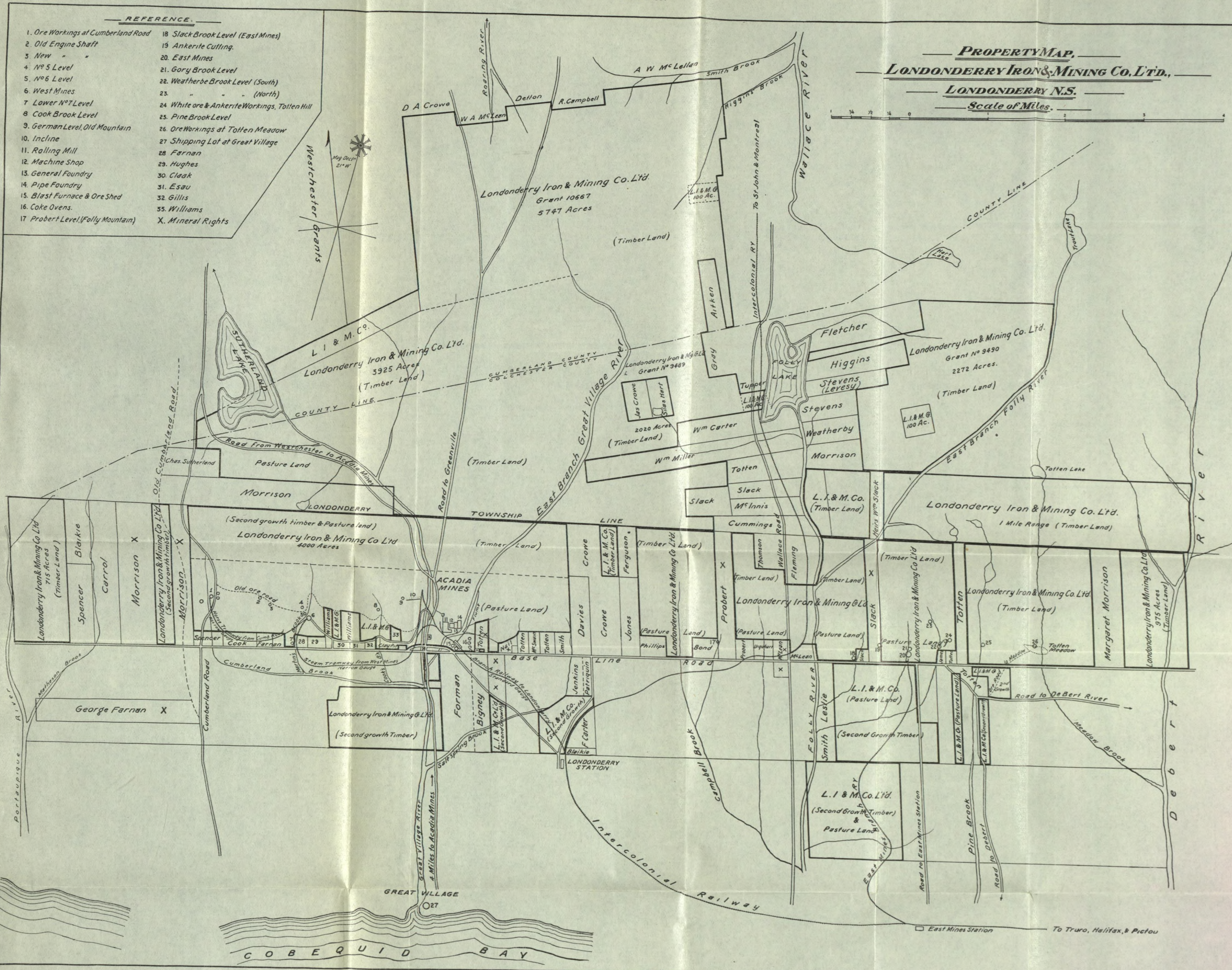
Outcrops of ore.—The westernmost location of iron on this range is on East river of Five Islands. Here ankerite and quartz occur at the Devonian-Carboniferous contact. A mile farther up stream, close to the first contact of the igneous rocks, iron is again met. How much indication of ore there is between these two points is not known.

Eastward, at the east branch of Beaver brook, the Devonian band narrows down to practically nothing through the encroachment of igneous rocks from the north, so that all iron occurrences to the eastward are probably cut off completely from those to the west.

The next good section is exposed by Economy river. Just above Economy falls, which are close to the contact of the Devonian and Carboniferous, are cliffs of greenish shales similar to some associated with iron farther east; but no ore. Two miles above here, in the granite area, the river forks. About 4,450 feet north of this are "dark bluish gray rusty beds, very like the darker portion of the Londonderry iron series. In the planes both of jointing and bedding are films of specular iron ore. Certain bands have a peculiar appearance, as of altered underclay, so often noticed in the iron ore series." These might easily be the strata of the Londonderry range repeated by folding, with the intervening area subsequently intruded. At about 5,500 feet from the fork are "light gray cream-colored and rusty slates, containing veins of specular iron one-fourth of an inch thick."

On Murphy brook, a tributary from the north, "after crossing a great breadth of igneous rocks are purple and greenish altered slates, with quartz veins and blotches of specular ore."

4


Property Map,
Londonderry Iron & Mining Co. L'td.,
Londonderry N.S.
Scale of Miles.
Reference.
1. Ore Workings at Cumberland Road
2. Old Engine Shaft
3. New " "
4. No 5 Level
5. No 6 Level
6. West Mines
7. Lower No 7 Level
8. Cook Brook Level
9. German Level, Old Mountain
10. Incline
11. Rolling Mill
12. Machine Shop
13. General Foundry
14. Pipe Foundry
15. Blast Furnace & Ore Shed
16. Coke Ovens.
17. Probert Level (Folly Mountain)
18. Slack Brook Level (East Mines)
19. Ankerite Cutting.
20. East Mines
21. Gory Brook Level
22. Weatherbe Brook Level (South)
23. " " " (North)
24. White ore & Ankerite Workings, Totten Hill
25. Pine Brook Level
26. Ore Workings at Totten Meadow
27. Shipping Lot at Great Village
28. Farnan
29. Hughes
30. Cloak
31. Esau
32. Gillis
33. Williams
X. Mineral Rights
Westchester Grants
Londonderry Iron & Mining Co. L'td. Grant 10667 5747 Acres
(Timber Land)
Londonderry Iron & Mining Co. L'td. 3925 Acres (Timber Land)
L I & M. Co.
Sutherland Lake
Folly Lake
County Line
Cumberland County
Colchester County
Londonderry Iron & Mining Co. L'td. Grant No 9490 2272 Acres. (Timber Land)
Londonderry Township Line
Londonderry Iron & Mining Co L'td 4000 Acres
(Second growth timber & Pasture land)
Londonderry Iron & Mining Co. L'td. 1 Mile Range (Timber Land)
Londonderry Iron & Mining Co L'td 715 Acres (Timber Land)
Londonderry Iron & Mining Co. L'td. (Timber Land)
Londonderry Iron & Mining Co. L'td 375 Acres (Timber Land)
Acadia Mines
Base Line Road
Londonderry Station
Great Village
Cobequid Bay
Intercolonial Railway
East Mines Station
To Truro, Halifax, & Pictou
Wallace River
Folly River
Great Village River
Debert River
Portapique River
East Branch Great Village River
East Branch Folly River
Road to Greenville
Road from Westchester to Acadia Mines
Old Cumberland Road
Cumberland Road
Road to De Bert River
Road to Debert
Road to East Mines Station
Pine Brook
Campbell Brook
Meadow Brook
Smith Brook
Higgins Brook
Roaring River
To St John & Montreal
Intercolonial RY
4 Miles to Acadia Mines
George Farnan
Morrison
Spencer
Blakie
Carrol
Fletcher
Higgins
Stevens
Weatherby
Totten
Slack
Forman
Bigney
Crowe
Davies
Jones
Probert
Smith
Leslie
Margaret Morrison
A W Mc Lellan
D A Crowe
W A Mc Lean
R. Campbell
Wm Carter
Wm Miller
Pasture Land
(Second growth Timber)
Totten Lake
Totten Meadow

At Little Bass river the Devonian is less than half a mile wide. The second or broad band of the same starts two miles beyond. In the former, north of a small outlier of Carboniferous rocks close to the contact with the Devonian, the strata show that "there is no break in the continuity of the iron ore series, as developed at the Londonderry mines, their identity with which is indisputable." Little Bass river is the easternmost one shown on the Economy river sheet (Geol. Surv. Can., doc. 839; sheet No. 76).

At Big Bass river the Devonian has become a mile wide, but is interrupted by narrow east-west bands of intrusives. Going northward, the Carboniferous rocks "are succeeded in cliffs in a gorge by quartzites of the iron ore series, associated with syenite and diorites." On Miller brook, an east branch, a mass of paint ore was in 1906 being explored in the bank, a mile above the mouth of the brook and between 200 and 300 yards north of the Devonian-Carboniferous contact. The stream appeared to be running on the strike of the body, giving the deceptive appearance of a wide deposit.

Sample 54 was taken from this opening.

	No. 54
Fe	10.71

Between Big Bass river and Portapique river no exploration was attempted.

THE RANGE—(2) LONDONDERRY IRON AND MINING COMPANY PROPERTY.

From Portapique river to Debert river, a distance of fourteen miles, the iron ore lands are owned by the Londonderry Iron and Mining Company. At this place only a description of the ore distribution will be given. (See Plates 37, 38 and 39).

Portapique river to West Mine.—Portapique river appears to be unfavorable to the outcropping of ankerite veins. Staining is found 2,500 feet north of the contact with the Carboniferous, and boulders with ankerite veins 1,000 feet farther up stream. Carbonate and bottle ores are met in Matheson brook from a few feet north of the contact for 1,000 feet up stream. Eastward from this stream the indications are continuous and abundant. As the brooks are unusually poor lines of traverse for exploring the veins, owing perhaps to the solubility of the latter, it has happened in a few places that streams gave ore indications for only short distances, while the hills showed the ore bearing zone to be broad. Such places have been indicated on the map (Plate 37) by two lines, one representing the northern margin of the zone as shown in the brook, the other the same margin as it probably runs. The greatest breadth of the zone in this part of the range is west of Cumberland brook, approximately 5,800 feet.

From Lornevale east the iron zone is bounded on the south by a black slate. The very variable breadth observed in various places, and the scarcity of outcrops, make it difficult to determine what rocks normally bound the zone on the north.

Cumberland brook to East Mines.—The ore zone narrows eastward from Cumberland brook, until at Martin brook it is 2,300 feet across; at Cook brook it is 3,300. At the west branch of Great Village river, the northern edge of the zone turns sharply southward to avoid a spur of the Cobequid intrusives, thus constricting the former. On the east branch a clear section shows the zone to have a breadth of 1,000 feet. To the west of the west branch, where the total breadth of the zone is much greater, the margins, especially the northern, appear to have much less iron than a strip somewhat south of the centre; but here the whole breadth is heavily impregnated with ore. All the rock whose nature permitted has been mechanically shattered and chemically altered.

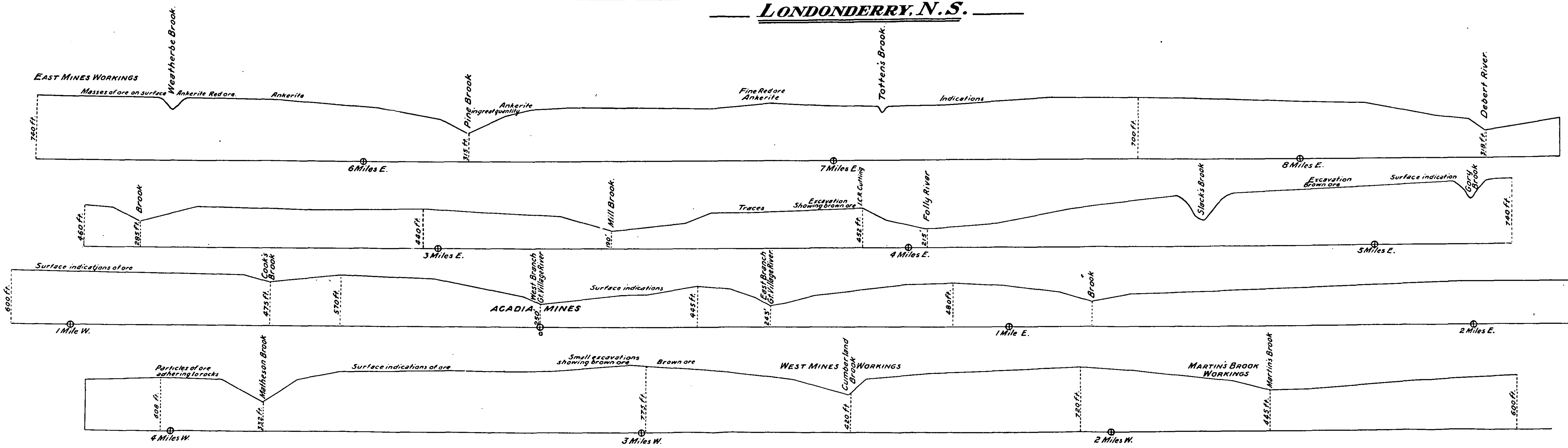
From the east branch eastward the zone widens to 2,000 feet, probably remaining broad although not well exhibited in the brook sections. The deep gorge of Folly river, east of the Intercolonial railway, gives the best section of any of the streams for exposing ankerite veins. On Slack brook, where the westernmost of the East Mines workings begin, the breadth of ore-bearing rock is 1,350 feet. Thence eastward through the greater part of the worked area the southern margin keeps very close to the Carboniferous contact and the northern one is hidden by glacial debris. At Pine brook the breadth is 2,650 feet, part being occupied by two bands of intrusives, and no openings have as yet been made north of the second of these. In the Peter Totten meadow, north of the only band of eruptives which occurs here, the ore zone is 1,050 feet broad. In the valley of Debert river the great amount of igneous rock leaves little space for the sediments. North of the first band of the former is the continuation of the southern part as shown at East Mines, but it possesses no possibility of economic value.

Association of the ores—The relations of the ores to each other give a clue as to the probable permanency of those parts which are of sufficiently high grade to pay for working.

The surface mineral is usually limonite or other hydroxide of iron. This varies on the one hand from black, botryoidal or bottle ore, extremely hard and very pure, to yellowish brown ochre, the paint ore of the miners. The bottle ore is shallow and local, characterising certain restricted districts; and appears to be quite recent in origin, largely occupying cavities in other ore or in the wall rock. No very large tonnage of bottle ore has been mined, nor could such be expected.

Another fairly superficial ore is the specular. Doubtless it should be called specular hematite; but its streak is brown rather than red, often even yellowish, and it contains a variable percentage of water. There is need of a variety name to designate such a mineral. The specular ore is fine to coarse, and occurs in form from thin filaments and stringers in other ore up to large

APPROXIMATE PROFILE ALONG LINE OF ORE-BEARING ZONE, FROM MATHESON BROOK TO DEBERT RIVER, LONDONDERRY, N.S.



pockets of many tons. Like the bottle ore it is one of the most recent formations; but it is in far larger amount than the former and does not line cavities, but forms a dense mass. It is developed locally, owing to causes which are not apparent. In some instances it is near igneous rocks which, however, long antedate its formation. In others it has no environment which might be used as a clue. Thus, analyses of the Totten brook old workings at East Mines show a comparatively large percentage of specular ore, while westward toward Slack brook there is little, limonite being the oxide. In this case proximity of igneous rocks might at first sight appear to account for the change to specular ore. But in the western part of the property now worked—Cumberland brook and West Mine—the ore west of the brook consists of a mixture of ankerite, siderite and specular iron. Eastward toward Martin brook are ankerite and so much bottle ore that this part is called by the miners the black range. In this case intrusives could under no circumstances have influenced the ores. It may be that differences in intensity of the strains and stresses exerted within the rocks, during or after the period of deposition of the minerals, can be held to account for the marked localization of the specular ore; this variety occuring where recent disturbance has been greatest or where superior rigidity gave greater resistance to whatever disturbing forces were in action.

Not far below the general drainage level of the country, all the mines so far developed have encountered too large a percentage of ankerite and siderite and have been obliged to cease operations downward. The deepest workings—those at Cumberland brook—became idle because of this and because of an increase in the percentage of sulphur, probably in the form of barite (barium sulphate).

History of Acadia Mines.

Early history.—Iron ore in the vicinity of Great Village river seems to have been known ever since the granting of the lands. In 1845 Abraham Gesner and J. W. (later Sir William) Dawson examined the district for private parties. In 1849 the first commmercial operations were set on foot by the Acadia Iron Works, the equipment consisting of six Catalan forges, a puddling furnace, metal helve, blower, and set of crushing rolls. In 1852 the first charcoal blast furnace for making pig was started and continued in service intermittently until 1875. In 1870 the first steel works were erected and the forges were abandoned; and in 1874 or 1875 Dr. Siemens made there his first commercial experiment in the direct conversion of iron into steel, and failed. In 1877 the steel plant was demolished, its site being used for rolling mills, adding these to one which had been built in 1860. The first coke ovens were built also in 1877.

Londonderry Iron and Mining Company.—For a long time previous to 1885 the property was owned by the Londonderry Iron Company. In 1886 it was purchased by the Steel Company of Canada, which went into liquidation in 1899. Both companies appear to have failed in part through depression in the market. In 1902 the Londonderry Iron and Mining Company took over the property, which comprises about 33,000 acres, including for the most part both land and the mineral rights. In a few portions, only the latter are secured. Between 18,000 and 20,000 acres are in wood, giving ample supply for either mining or metallurgical use. Since the beginning of 1904 the furnace, entirely remodelled, has been in constant use.

The company operates about ten miles of standard and narrow gauge railway. The former runs from Acadia Mines to Londonderry station; and from East Mines station, on the Intercolonial railway, to East Mines. The narrow gauge includes a line between Old mountain, west of the west branch of Great Village river, and Martin brook; and between the latter and Cumberland brook. Plate 38 shows in detail the holdings of the Londonderry Iron and Mining Company, and the character of them.

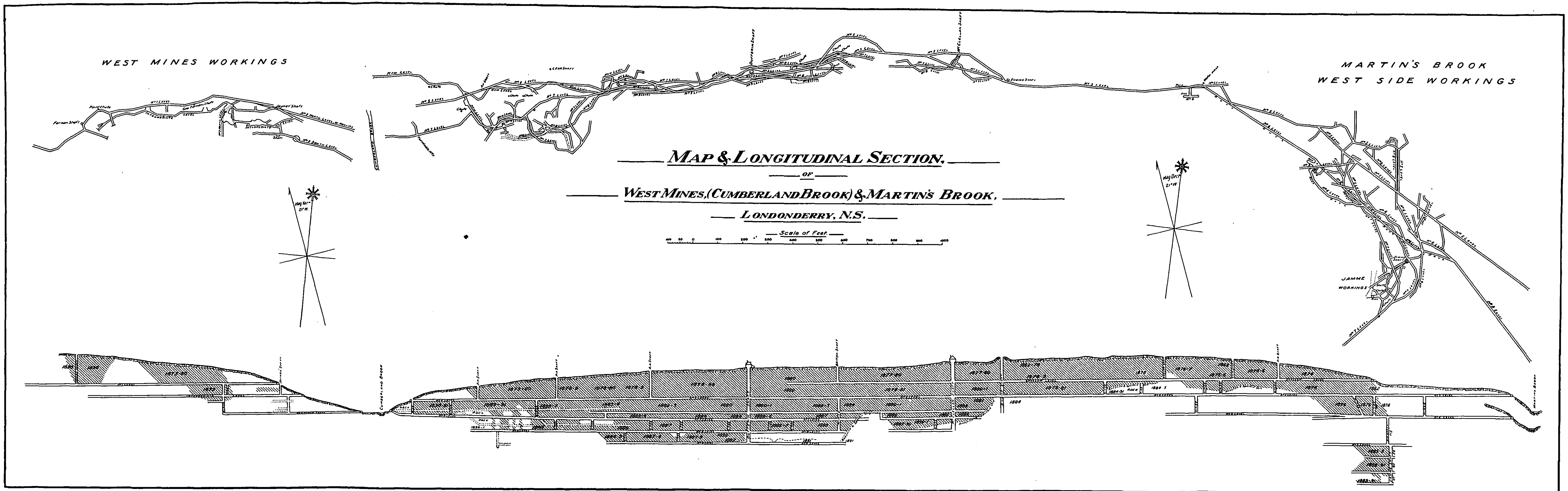
The history of the various parts of the property is given below, from the mining standpoint. The districts worked, already referred to in various connections, are Cumberland brook or West Mines (between this and Martin brook) Martin brook, Cook brook, Old Mountain, and East Mines. The latter could well be subdivided into the smaller units of the Slack brook, Gory brook, Wetherbe brook, Pine brook and Totten brook workings; but as they are not all well separated, and the information regarding some of them is meagre, this is not attempted.

Mixture of ores.—Since early in 1903 Torbrook hematite and magnetite from the Leckie mine, and more recently from the Wheelock mine on the Shell bed and Martin mine on the Leckie vein, have been mixed with the Londonderry ores. The two supplement each other, the former being high in phosphorus, the latter slightly lower in iron, but exceedingly low in phosphorus and sulphur, and often nearly self-fluxing by reason of its content of lime and magnesium carbonates. This last quality—due to the ankerite—is almost unique. At times limestone has been used as a flux, being brought from Brookfield (Colchester county) and elsewhere, but finally abandoned for the ankerite. This mineral answers the purpose, and, on account of the percentage of iron which it contains, admits of the use of a lower grade ore than would otherwise be feasible. On the other hand its iron is variable, owing to intermixture of specular ore, and creates difficulty in gauging the charge mixture and causes irregularity in the action of the furnace.

Output.—The output of this and other districts will be given in detail in a subsequent volume. The total yield from Acadia Mines since 1849 is over 2,000,000 tons of brown ore alone.

Description of Mines.

The distribution of ore in the mines at Londonderry and vicinity is so irregular, and the necessary type of mining so unsystematic, that detailed description of the underground workings would be difficult to make with accuracy on account of imperfect records, especially of earlier work; and it is doubtful whether such description would be particularly interesting.


WEST MINES WORKINGS
MARTIN'S BROOK
WEST SIDE WORKINGS
MAP & LONGITUDINAL SECTION.
OF
WEST MINES, (CUMBERLAND BROOK) & MARTIN'S BROOK.
LONDONDERRY, N.S.
Scale of Feet.
JAMME WORKINGS
CUMBERLAND BROOK
MARTIN'S BROOK

Much of the knowledge that is possessed regarding the distribution of ore, ankerite and rock is laid on the maps and sections of the several mines. But as it is difficult, in plotting such irregular mining as has been necessary here, to make the various rock cuts clear without great expense in colour printing, some description is given below of part of the underground excavations. It is to be regretted that the sections are not in all cases completed up to the date of the maps, or to the summer of 1906.

Cumberland or West Mine: west side.—The westernmost mine on the property is that extending westward from the west side of Cumberland brook toward Matheson brook (See Plate 40). No. 1 level starts approximately 120 feet above the brook and 595.6 feet above sea level, and extends to a point 980 feet west of its entrance and 1,400 feet west of the brook. As it is sinuous, its length is greater than the former figure. An intermediate level lies 50 feet below No. 1. There are two levels numbered 2; the older northern or Hoskins level, and a newer short drift on the south, both starting but little above the brook bed. The brook is here 478.8 feet above the sea.

No. 1 level appears to have run in ore through most of its length. This is true of the older workings as a rule, partly because they were shallow and in larger and more frequent ore bodies than are found at greater depth, and partly because in the early days little expense was incurred for underground prospecting. A notable exception to the latter occurs at Slack brook, East Mines, noted later.

The Intermediate is another old level, reopened and extended in recent years. The older workings were in ore; and in two places, as marked on the plan, large pockets of mixed ore and ankerite have been taken out. The whole of the western or newer half of the level, however, is in rock.

About No. 2 north level no information is available. No. 2 south level started in rock and first struck ore in a round pocket of ankerite, marked upon the plan. Thence onward its course has been chiefly in ankerite.

Not enough underground work has been done to show how great a body of ore is present toward Matheson brook; but there is no indication that the iron ends. Indeed, surface evidence points to a considerable amount of ore extending as far as the western stream. Downward the operations are too meagre to prove to what extent the oxides are replaced by carbonates above the drainage level of the country; but it is evident that the same condition obtains here as elsewhere in the range, namely, that the distribution of the oxide alteration products bears a very close relation to the present topography.

Cumberland: east.—By far the most extensive workings in the district are those extending from Cumberland east to Martin brook, and called as a whole West Mine (Plate 40.) The upper or No. 5 level extends from one brook to the other, a length of over 4,400 feet in a straight line, and considerably greater by the tunnel through the sinuosity of the latter. The whole was run in ore and all the good ground stoped out to the surface. Along most of the course other lower levels were driven and much of the ground stoped out; but for approximately 750 feet, at a point about two-thirds of the distance east from Cumberland brook, No. 5 is the only level and no rock has been cut below it for a still greater length. A tunnel called the Shallow level, lying above No. 5, was driven from Martin brook west for 2,325 feet in the early years of working; but through the complete stoping out of the ground both above and below it, it has long since become obliterated.

The deposit is tapped by three vertical shafts. The western, the Dufferin, is located 1,340 feet east of the west end of No. 5 and extends 310 feet down to No. 9 level, the bottom of the workings at this point. The second, the McClellan, is 820 feet east of the former and is 280 feet deep, reaching a short local level corresponding to No. 9 from Cumberland brook. The third, the Engine shaft, is 225 feet east of the McClellan and 225 feet deep, ending blindly below No. 5 level. There are, in addition, numerous air shafts and a number of winzes.

The earliest work on the west or Cumberland brook side appears to have been in 1875, and operations continued until 1891. During that time several levels were driven for long distances, only two, however, opening on the brook side. These were No. 5, already referred to, and No. 7; Nos. 8 and 9 and an unnumbered level above No. 7 were blind. The character of the stoping and its dates are shown in the profile. Beyond this it is difficult to get information, as the work is all old. The decrease in quantity and quality of ore downward is indicated in the profile, and it will be noticed that the works stopped but little below drainage level; also that the carbonates extend quite irregularly up into the oxidised zone, as between the Dufferin and McClellan shafts, where they are but 70 feet below the surface. No. 7 is approximately at the level of Cumberland brook, and the lowest ore mined, that on No. 9, is less than 100 feet below this. In the plan it will be noted that while near Cumberland brook the levels covered a breadth of 300 feet, in going east either the ore-bearing belt narrows or the same amount of effort was not made to trace it; for the levels lie upon a single narrow fissure. The tortuous course of the ore is also brought out by the plan.

A new level, not entered upon the profile but shown on the map, has been driven within two or three years from Cumberland brook east into the broader part of the ore; but it has not reached a great distance on the strike as yet.

Martin brook: *west*.—On the west side of this brook the workings are not very extensive, but are interesting on account of the depth reached in the Jamme shaft (Plate 40). The earliest work done was in 1862, in the form of a large amount of excavation above the Shallow level. The main part of the mine was opened and stoped between 1875 and 1891; and here, as at Cumberland, a renewal of operations has been attempted within the last three years, through the reopening of No. 6 level. Much of the work has been in rock, and what ore was encountered was in the form of pockets of ankerite and siderite with variable amounts of oxide.

The Jamme shaft is developed upon a large pocket of ore by a winze shaft from No. 7 level. The latter is 90 feet below No. 5, the inter-brook level, and


PLAN & SECTION OF
SURFACE & UNDERGROUND WORKINGS,
COOK'S BROOK & OLD MOUNTAIN,
LONDONDERRY N.S.
Scale of Feet
100 50 0 100 200 300 400 500 600 700 800 900 1000
COOK'S BROOK WORKINGS.
Mag. Decl. 21° W.
OLD MOUNTAIN WORKINGS
ROAD
Magazine
Office
Blacksmith
Ankerite Quarry
Ankerite Pit
Incline
Tram Road
Narrow Gauge Railway
GREAT VILLAGE RIVER
Blacksmith
Magazine
No 4 Level
No 3 Level
No 2 W. Level
No 2 E. Level
No 1 W. Level
No 1 E. Level
Gallagher Works
No 4 Level
No 5 Level
No 6 Level

PLATE 42.

(*a*) Wheelock shaft house: Torbrook district.

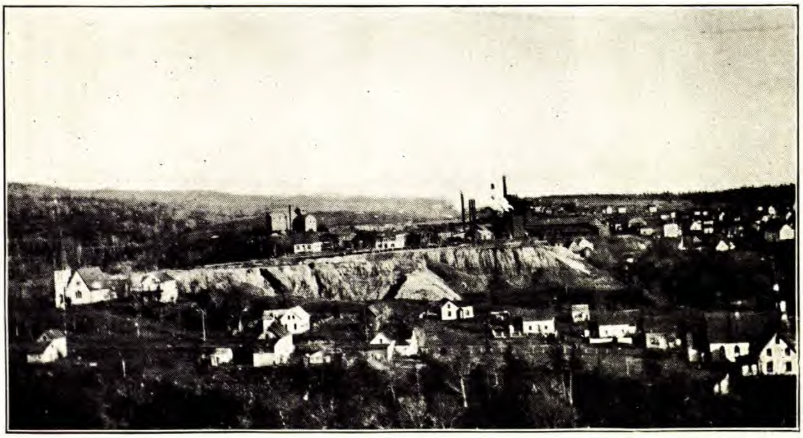
(*b*) View of Cumberland Brook openings: west side.

PLATE 43.

(*a*) General view of valley of Cumberland brook and loading platform.

(*b*) Martin Brook openings: west side.

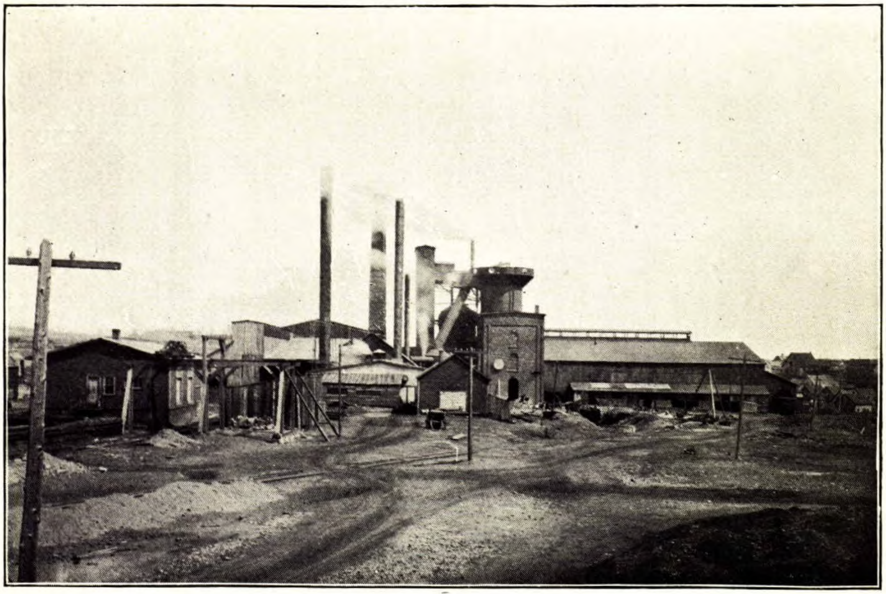
PLATE 44.



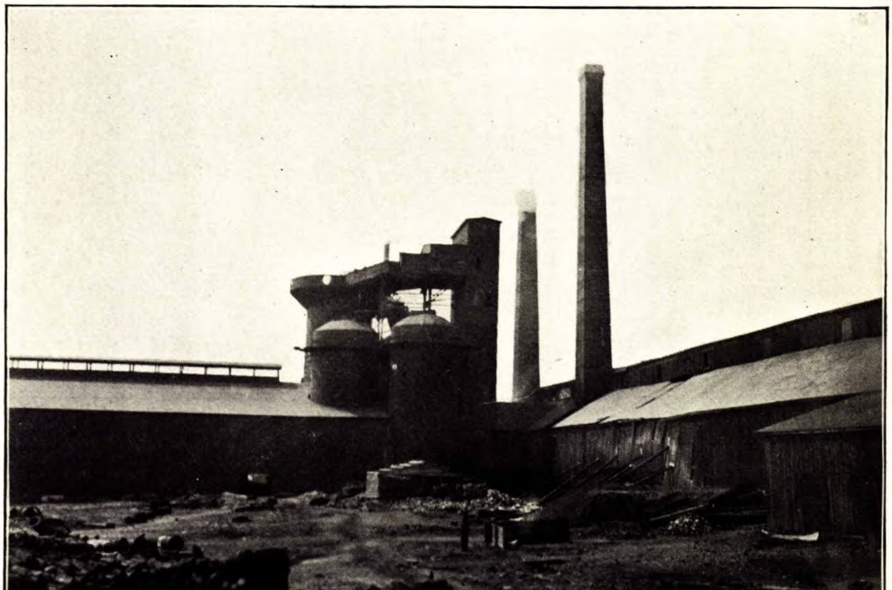
(*a*) General view of furnaces: Londonderry.

(*b*) General view of valley of Great Village river, east branch.

PLATE 45.



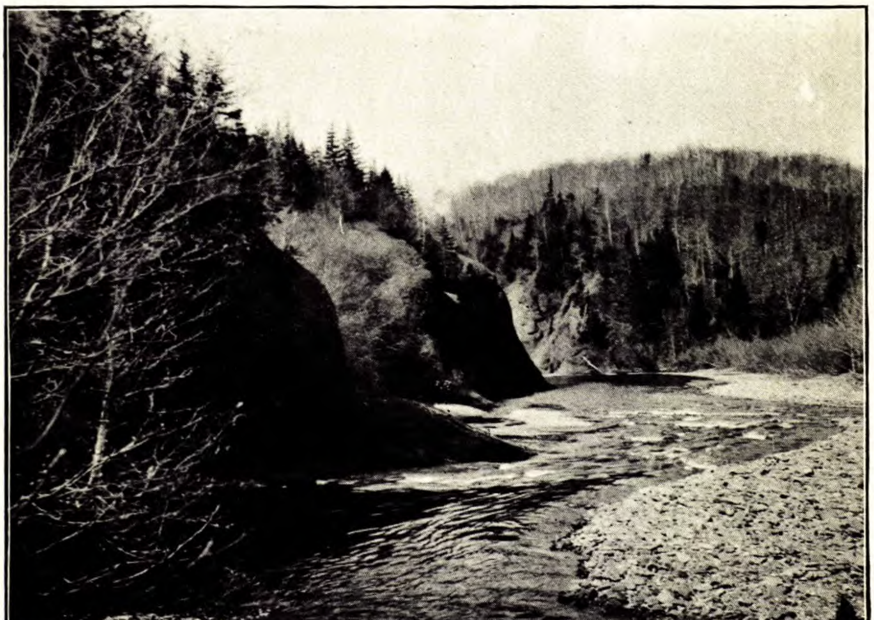
(*a*) Blast furnace: Acadia Mines.



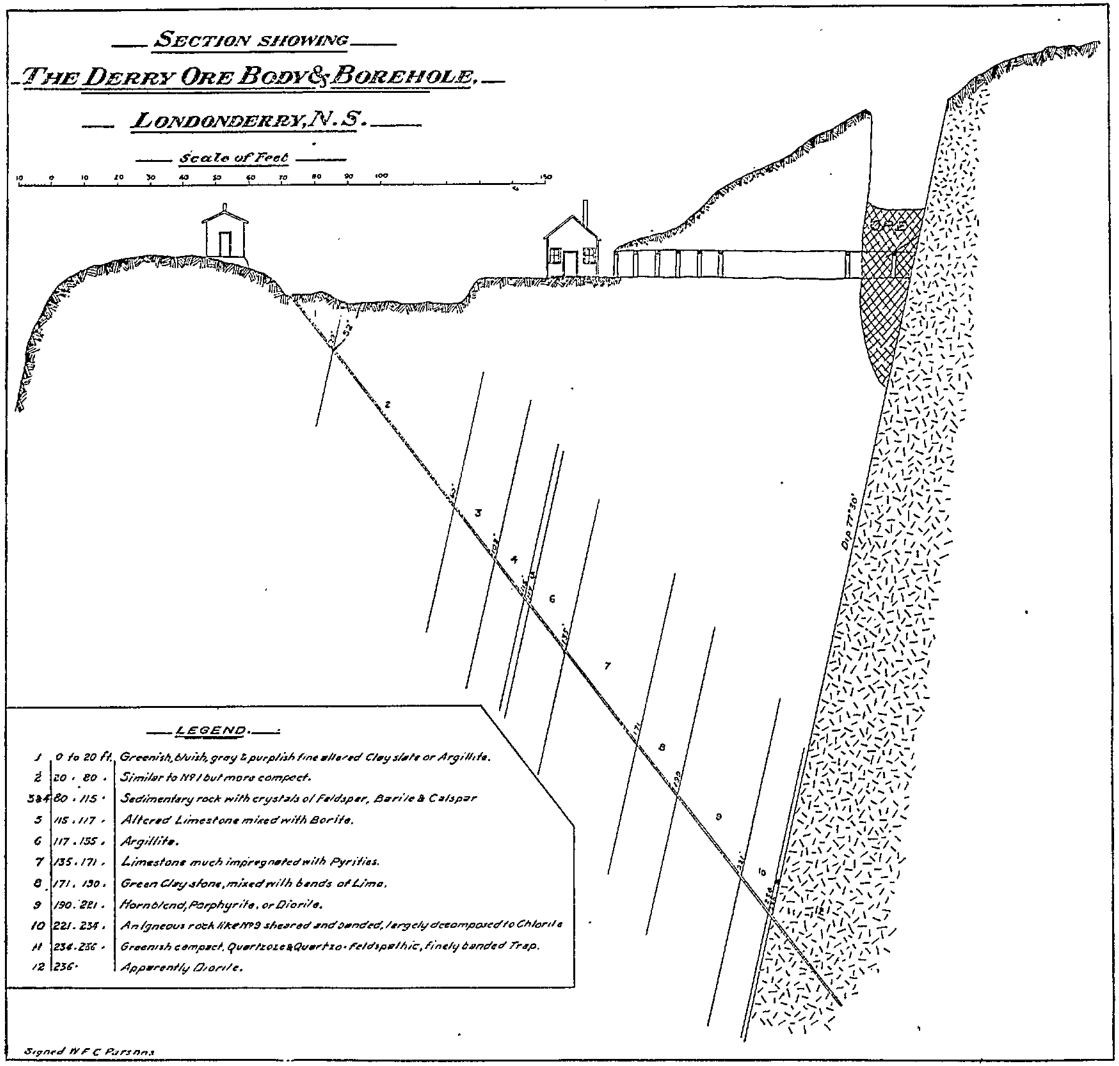
(*b*) Blast furnace and Stock and Pig Sheds: Acadia Mines.

PLATE 46.

(*a*) Falls, west branch of Great Village river.



(*b*) Head of gorge, Great Village river, below Londonderry.


SECTION SHOWING
THE DERRY ORE BODY & BOREHOLE.
LONDONDERRY, N.S.
Scale of Feet
ORE
DIP 77°30'
LEGEND.
1 0 to 20 ft. Greenish, bluish, gray & purplish fine altered Clay slate or Argillite.
2 20 · 80 · Similar to No 1 but more compact.
3&4 80 · 115 · Sedimentary rock with crystals of Feldspar, Barite & Calspar
5 115 · 117 · Altered Limestone mixed with Barite.
6 117 · 135 · Argillite.
7 135 · 171 · Limestone much impregnated with Pyrities.
8 171 · 190 · Green Clay stone, mixed with bands of Lime.
9 190 · 221 · Hornblend, Porphyrite, or Diorite.
10 221 · 234 · An Igneous rock like No 9 sheared and banded, largely decomposed to Chlorite
11 234 · 236 · Greenish compact, Quartzoze & Quartzo-feldspathic, finely banded Trap.
12 236 · Apparently Diorite.
Signed W F C Parsons

the total depth of the Jamme shaft below No. 7 is 157 feet. The full height of land between the two brooks is by no means attained at this point, so that No. 5 is only 90 feet below the surface, while farther west it attains a depth of 160 feet. But the dimensions of the Jamme workings make them the deepest in the district, approximately 400 feet from the surface and 230 feet below the level of the brook at its nearest point.

It is stated that in these and the Cumberland workings not only does the ore become lean downward, turning to carbonates, but the proportion of sulphur increases rapidly.

Martin brook: east.—This level (see plate 40) has been re-opened into a succession of crushes. It proceeds obliquely into the hill on the east bank of the brook, striking bedrock at 410 feet from the mouth; thence turning magnetic north it crosscuts alternating dark slates and sandstones for 607 feet. An old level, now caved in, continued through the same rocks for 240 feet to a chimney of ore, the place of which is now occupied by a crush of boulders and clay. To avoid this a new level has been turned off north-eastward from the old, and thence parallel with it, but met the crush at 270 feet and continued in it for 75 feet. After 8 feet of rock a second crush was met, and the level abandoned.

Cook brook.—The workings at Cook brook have not developed much ore, although the tunnelling has been quite extensive. Seven levels have been run, three on the west side and four on the east. The lowest are No. 1 west and No. 1 east, starting almost at the level of the brook and at 484·5 feet elevation. Both are straight in their course; and developed little ore, being run largely in rock. No. 2 east and No. 2 west are up stream from the first two, and at elevations of 535·4 feet and 538 feet respectively. Like those below, they run obliquely to the right and left into the banks of the stream, and they are developed largely in ore.

No. 4 level is the highest and farthest up-stream, on the west side, its mouth having an elevation of 571·1 feet. It is developed almost entirely in ore. No. 3 and the Jonah level, the latter being old workings, extend north-eastward from the east side of the stream, at an elevation of 565·5 feet. They are connected, and each has several ramifications. These contain almost the only stoping in the district; and altogether the information Cook brook gives regarding distribution of ore is very meagre. One point is notable, however, namely, that the ore followed is by no means confined to a narrow fissure vein extending parallel with the mountain range, as the ore of Londonderry is usually described as occurring. No ore has been mined below the local drainage level; and no positive evidence exists as to the downward limit of the oxides here.

Old Mountain.—On the west side of the west branch of Great Village river is much of the older surface and shallow underground excavation; and here also, much of the recent work has been done. The surface, well toward Cook brook, is pitted with ankerite and ore quarries; and one level ends within 650 feet of No. 3 level from Cook brook.

There are four principal levels, besides several small and at present unimportant ones. These all extend westward toward Cook brook, and are numbered from south to north 4, 1, 2, and 3. Their mouths are at very different distances from the river, according not only to their heights but to the portion of the ore zone which they tap. The width north and south occupied by the old and new workings is slightly over 1,200 feet; the extreme length, from the first workings on the river bank to the end of No. 2 level, approximately 2,100 feet.

All the main levels are connected by narrow gauge railway, either with each other or directly with an incline which starts off the mouth of No. 1 level, and ends at the river against ore chutes 250 feet below.

No. 4, the southern level, starts 300 feet west of the river and at an altitude of 425·56 feet. The narrow gauge railway below has an elevation of 283·66 feet at the bridge across the river. The drainage level would be approximately 250 feet in altitude, and no mining has been done at so low a point. Indeed, the few western instances already noted are the only ones in the whole Londonderry range. No. 4 level was run largely in ore, but little stoping was done. The end of the level is 400 feet west of the mouth, and the direction quite irregular.

Two very short levels, Nos. 5 and 6, lie at lower altitudes than No. 4, the latter being at 285·4 feet. But they are too short to have any effect upon the mining of the district.

Next north of No. 4 is No. 1, one of the two main workings of Old Mountain. This starts 800 feet west of the river, at an altitude of 532·31 feet. From its mouth the main inclined roadway descends to the shipping chutes. A tramway from No. 4 runs to a landing half-way down this incline. The character of the level, its sinuosity and ramifications, may be found upon the plan better than any description would convey. The tunnelling was alternately in rock and ore, the latter not lying in a single well-defined vein, as might be gathered from the early literature on the district. This is at present one of the chief sources of the brown ore, now largely paint. A very noticeable feature is the large ankerite quarry, showing a length east and west of 200 feet, and a breadth of 125 feet, and thus one of the largest in the district.

North 500 feet from No. 4 is No. 2, at an altitude of 533·76 feet at the mouth, which is 1,100 feet west of the river. This is the second working of importance, extending to a point 1,050 feet west of the mouth. Like No. 1 this is tapped overhead by several quarries and pits, and in places is stoped out to the surface. The distribution of ore and rock is sufficiently shown on the plan.

The northernmost level, No. 3, has been receiving most attention of late, having been much extended westward. It starts at a distance of 750 feet from the river, and an elevation of 450·52 feet, and its present face is 1,100 feet west from its mouth. Owing to its great sinuosity the tunnel is in reality much longer. Its first course takes it 200 feet north of No. 2 to the Gallagher workings, where considerable stoping was done. Thence the drift works gradually south to a point under No. 2 and on the same ore, where a large amount of iron has been encountered. Toward the west end, a small cross fault has been met, not, however, offsetting the ore to any extent. Such breaks are rare in the district.

No. 2 is connected with the shipping chutes by a direct oblique incline. No. 3 is connected with the top of the main incline at No. 1 by a tram, and one or two small quarry workings along the line have spur tracks from this tram.

The distribution of the workings, both here and at the western mines, indicates that the ore is not in one or two veins only, but more widely distributed in a north and south direction; and the evidence gained by surface traverses, as related earlier in the chapter, tends to confirm this view.

A notable exception to the classes of ores characteristic of the Londonderry range is the Derry hematite; a contact body found near the upper bridge across Great Village river, a mile above the village of Acadia Mines. At this point a small brook joins the river from the west, and the north side of the brook valley is steep. Close to this valley on the north, a large projection from the main body of Cobequid intrusives has its south contact. From this contact the Devonian sediments dip sharply to the south, striking nearly east and west. Their character and attitude, as exposed by an adit near the valley bottom and by inclined bore-hole, are shown in the accompanying cross-section (Plate 47).

At the contact was recently discovered a body of flinty black hematite, highly vitreous in lustre, compact and hard. The early assays gave very high insoluble matter, but the ore was developed in the hope that it might prove better in depth. The chemical results are shown later in the chapter. The silica, always high, at last became prohibitive in amount. The appearance as indicated by excavation was that of a portion of the sediments adjacent to the contact replaced by a highly siliceous iron, which thus is bounded by non-ferruginous sediments on the south and by diorite on the north. The extent on the strike is not known but is evidently not great to the eastward, for it does not appear in a complete section exposed in Great Village river. In depth the increasing silica content of the ore shows the gradual diminution of iron replacement, and the drill-hole brought to light no ore at the contact. The occurrence is especially interesting, as showing what may be expected in an igneous contact deposit. The total tonnage extracted was not great.

Great Village river to Folly river.—Although the iron bearing zone has long been known to extend through the country between Old Mountain and East Mines, little has been done to explore it. A few short drifts, such as the Drummond, Ferguson and Bouthelier levels have been run, but no attempt appears to have been made to follow the ankerite and siderite for any distance. This may be because of an evident scarcity of brown and black ores, compared with the abundance in earlier years on Old Mountain and thence westward.

On the hill between the two branches of Great Village river are a number of shallow pits, as well as short levels. Thence eastward a few pits have been sunk to ore; but there is no underground development, except on Weigh-house brook, an adit which has been mentioned already. The extent of this is not known, but it is not great.

The Rogers ore has already been alluded to. The surface extent of this red hematite is probably not known definitely; but enough excavation has been made to show that it turns to carbonate even above the present general drainage level. It is thus a very recent formation. The abundance of bottle ore—the hard, black, botryoidal form of limonite—indicates a close resemblance to the conditions which obtained in the earlier years at Old Mountain, where earthy red hematite was found associated with bottle ore on the one hand, and with siderite (or more properly sideroplesite) and ankerite on the other. Whether much limonite in any form is present in the Rogers field, the development now proceeding will determine. The lower topography and the shallowness of ground-water level are against the probability of any such quantity as was found in the higher region from Old Mountain to Cumberland.

The natural exposures from Great Village river to East Mines have been described. There are no workings beyond those above mentioned, except a few pits made in prospecting and affording no evidence at present.

East Mines.—Beginning at Slack brook on the west a continuous series of surface and underground workings goes east to Gory brook, the total distance through which they are uninterrupted being 2,900 feet, (see Plate 48). The dates of earlier parts of the work cannot be discovered in detail. Much of it was quarrying, as the succession of large pits shows. The longest of these pits is that at Gory brook, running from the Reid to the McLean workings, 650 feet. Practically continuous with it on the west are two other quarries, giving a total length of 1,100 feet.

The old Slack brook level was in the form of a rock adit from near the main road east-north-east for 2,250 feet, past Slack brook and up to the west end of the Gory brook workings. The first 1,200 feet were in rock, the rest in ore, and but little stoping was done. This level taps only the south side of the ore zone. North of it is the Patrigan level, a rock adit northward about 120 feet long and just reaching into the northern part of the ore, which is a mixture of ankerite and paint. The relation of the two levels as shown upon the map indicates that the ore follows two zones, which are at this point about 400 feet apart and converging eastward, coming practically together at Gory brook.

The Gory brook workings consist, in addition to the extensive quarries still being operated, of a rock adit which runs northward for 175 feet; then bifurcates, one branch going north-west and west, the other north-east and east, the two connected by a drift along the ore. Two levels are or have been worked. The upper is 50 to 100 feet below the surface, according to topography, with a considerable amount of stoping. The lower is a continuation of the Slack brook level, connected with the other by shafts and upraises. The upper yielded a much larger proportion of ore, the lower shows chiefly ankerite with ore pockets. The extreme distance of the lower workings from the surface is 175 feet.

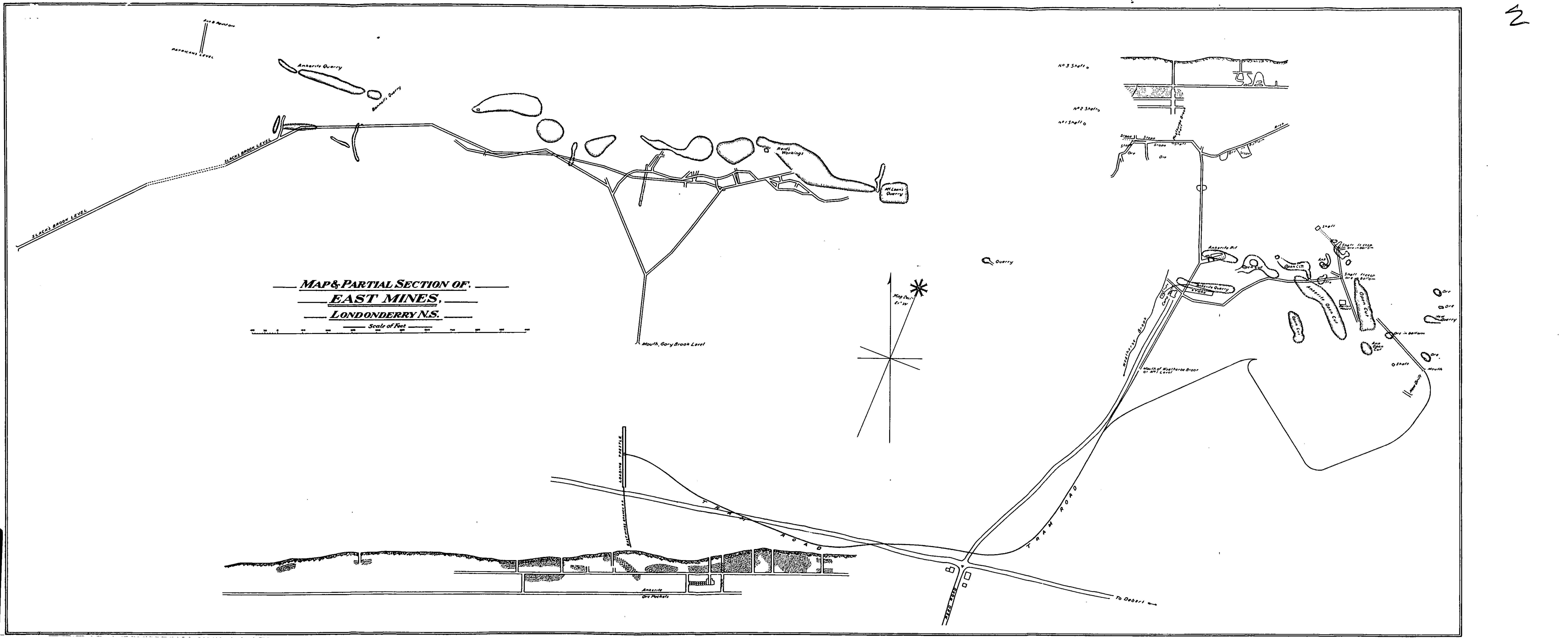
The other extensively mined district is that of Wetherbee brook, east of Gory brook. Here the productive zone comes to the edge of the Devonian, ore outcropping against the Carboniferous grits. Very many surface pits are opened; none, however, so extensive as at Gory brook. The underground development consists of one long level and several very short ones. The Wetherbee or No. 1 level starts from the end of a tram line well up on the hillside, and extends north-east for 350 feet to the ore zone; thence a spur runs irregularly eastward along the ore, and the main level continues north-east and north into a second ore zone at a distance of 400 to 500 feet from the first, there spreading east and west. This is recent work and includes some stoping, as will be seen by the section annexed to the map. At present the ore at this brook consists of four varieties—ankerite, siderite (the two combined in the current laboratory tests as general carbonate), paint and a small amount of specular ore. The last is erratically distributed in small and local veinlets in the paint and especially the carbonate ore, with the result that the proportion of iron in the carbonates is quite variable, requiring extra vigilance in furnace practice.

The veins in the East Mines district are much brecciated, and the wall-rock of green slate invades the ore as angular horses.

Eastward lie Pine and Totten brooks, where are not many openings dating back more than a few years; but large bodies of ankerite are being developed by exploration at present. The amount of oxide ore is not known.

It is noticeable throughout this country, and to a less extent at Acadia Mines, that the ground occupied by ankerite is hummocky, somewhat like gypsum and limestone land, but with less pronounced relief. The ankerite is usually found in hollows, which owe their origin to the weathering of this mineral. Another characteristic, which is not without exceptions, is that both the oxide and carbonate ores are poorly developed in stream bottoms. That the former should be absent is to be expected; but the latter would seem from other evidence to have been formed independently of any present topographic influence.

At Totten brook there are old openings on the side of the upland north of what is locally known as the Peter Totten meadow. Igneous rocks here form a band south of the ore and swamp; and, while there are indications of ore south of these and between them and the Carboniferous, no work has been done there. No recent mining has been done in the Totten field. The earlier excavations discovered a proportionately large amount of specular ore, making the shipments higher in iron than those of the other East Mines workings. In the early days all of this ore was calcined, 100 lbs. of the


MAP & PARTIAL SECTION OF,
EAST MINES,
LONDONDERRY N.S.
Scale of Feet
Ankerite Quarry
Reid's Workings
McLean's Quarry
Slack's Brook Level
Mouth, Gary Brook Level
Quarry
Ankerite Pit
Open Cut
Shaft
Ore
Tram Road
Loading Trestle
Ankerite
Ore Pockets
To Debert

calcined carbonate ore being equal to 140 lbs. of limestone in computing the charge at the furnace.

Chemistry Of The Ores

The West Mines and Old Mountain.—As many analyses are referable to the different geographic subdivisions of the property, this method of classification will be followed as far as practicable.

The analyses are largely from the laboratory books of the Londonderry Iron and Mining Company, and some of them have been published before. Such as are from other sources are especially noted in the text.

West Mines; no specified location.

L–1	Average of a pile
L–2	No data
L–3	Average of 14 samples of specular ore
L–4	Average of 14 samples of red hematite
L–5	Earthy red hematite
L–6	Black ores
L–7	"Specimens taken from a cavity of black ore"
L–8	Fibrous limonite
L–9	Brown hematite
L–10	Ditto
L–11	"
L–12	"
L–13	"
L–14	"
L–15	Average sample of brown ore
L–16	Calcined pyrite
L–17	Cream colored white ore
L–18	White ore
L–19	White ore and ankerite
L–20	White ore and ankerite mixed with paint
L–21	Ditto
L–22	"
L–23	"

West Mines; Cumberland.

L–24	Cumberland brook; limonite
L–25	North vein
L–26	South vein; limonite
L–27	No. 1, North lead, brown hematite
L–28	No. 2, South lead, brown hematite

L-29 Brown hematite from Shallow level

L-30 Ditto

L-31 No. 3, South level; black ore

L-32 Brown hematite from dump, No. 5 level

L-33 White ore from No. 5 level

L-34 Ditto

L-35 Brown hematite from roof of No. 5 level

L-36 White ore, No. 6 level

L-37—Ditto

L-38 Brown hematite mixed with specular ore; from foot-wall of big vein, No. 6 level

L-39 White ore, No. 9 level

L-40 Ditto

Anal. No.	Fe	SiO_2	Insol.	Al_2O_3	CaO	MgO	MnO_2	P	S	Vol. matter
L- 1	36.01	......	25.00	6.70	.18	.125	1.052	.462	.025	10.11
L- 2	40.61	......	......	......	......	......	......	......	......	34.30
L- 3	59.10	3.50	......	......	.92	......	......	......	.025	5.20
L- 4	59.50	1.60	......	......	......	......	......	......	......	11.70
L- 5	54.00	5.30	......	7.41	.49	.57	1.230	.080	.030	7.80
L- 6	56.90	6.30	......	......	......	......	......	......	......	......
L- 7	40.60	1.60	......	......	......	......	......	......	......	32.80
L- 8	59.17	2.37	......	.21	.22	.13	.170	.034	.001	11.99
L- 9	40.65	23.82	26.57	6.67	......	......	......	4.123	......	......
L-10	44.80	13.55	......	......	......	......	......	......	......	......
L-11	47.14	14.30	......	......	......	......	......	......	......	......
L-12	44.24	......	15.35	......	......	......	......	......	......	......
L-13	55.42	6.80	......	......	......	......	......	......	......	......
L-14	59.85	2.00	......	......	......	......	......	......	......	......
L-15	47.00	15.60	......	4.11	.87	.12	1.670	.057	.030	33.37
L-16	63.55	......	5.10	......	0.92	......	......	......	.290	......
L-17	31.814	.35	......	......	5.04	10.34	2.063	.008	......	......
L-18	......	.43	......	......	.73	27.87	1.643	......	......	......
L-19	......	.31	......	......	27.52	......	......	......	......	......
L-20	23.44	......	......	......	......	......	......	......	......	......
L-21	28.31	11.41	......	......	16.67	10.13	......	.062	......	......
L-22	......	11.80	......	......	......	......	......	......	......	38.80
L-23	......	11.20	......	......	......	......	......	......	......	37.30
L-24	57.25	5.37	......	.86	.52	.12	.256	.060	trace	10.68
L-25	58.27	......	......	.66	.88	.25	.878	.370	.016	11.51
L-26	67.85	3.05	......	.63	.57	.34	3.060	.190	.004	12.43
L-27	59.12	3.90	......	......	......	......	......	......	......	......
L-28	59.12	3.60	......	......	......	......	......	......	......	......
L-29	47.61	17.06	......	......	......	......	......	......	......	9.59
L-30	52.55	9.37	......	......	......	......	2.930	......	......	9.37
L-31	56.16	6.60	......	......	......	......	......	......	......	......
L-32	44.97	14.61	......	......	......	......	......	......	......	21.10
L-33	......	.71	......	......	5.83	23.78	2.623	......	......	......
L-34	......	.12	......	......	49.32	26.29	.830	......	......	......
L-35	47.84	15.27	......	......	......	......	......	......	......	26.52
L-36	31.04	.85	......	......	4.93	24.40	1.973	.013	......	......
L-37	......	.41	......	......	1.63	29.50	.533	......	......	......
L-38	48.94	3.77	......	......	......	......	......	......	......	26.58
L-39	33.40	3.90	......	......	3.42	......	......	......	......	32.30
L-40	33.40	3.70	......	......	2.80	6.65	......	......	......	30.10

Martin brook mine.

L–41 Limonite
L–42 Limonite; "ore is ochreous and botryoidal; fibrous structure within."
L–43 Kidney ore; fibrous botryoidal brown hematite; Sp.g. 3.85
L–44 Specular ore; very scaly structure; sp.g. 4.48
L–45 Ochreous brown ore
L–46 Earthy brown ore; sp.g. 3.13
L–47 Brownish white ankerite

Cook brook mine.

L–48. Specular ore; richer than average obtained on large scale; sp.g. 4.93

Old Mountain mine.

L–49 Earthy red hematite
L–50 Hard compact limonite; dark brown, lustreless; sp.g. 3.77
L–51 Ochreous yellowish brown limonite
L–52 Brown hematite
L–53 " "
L–54 " "
L–55 Paint from under the turf
L–56 Ankerite
L–57 White ore and ankerite mixed with paint

Anal. No.	Fe	SiO_2	Insol.	Al_2O_3	CaO	MgO	MnO_2	P	S	Vol. matter
L–41	58.30	4.30	......	trace	.39	.250	.500	.141	.001	11.21
L–42	57.85	4.79	......	.56	.15	.100	.305	.170	.008	10.82
L–43	57.76	2.28	......	.38	.16	.140	1.025	.097	.016	13.36
L–44	68.96	.66	......	.24	.08	.270	.195	trace	trace	......
L–45	53.87	......	......	......	......	......	......	.104	.024	......
L–46	58.22	4.12	......	.42	.13	.150	1.269	.128	.008	10.67
L–47	11.63	.044	......	......	27.48	12.384	.653	......	......	......
L–48	67.85	......	1.26	.32	.01	.110	trace	.003	none	.81
L–49	53.50	9.45	......	8.12	2.50	.490	.490	......	......	2.85
L–50	58.27	1.93	......	.66	.88	.250	.878	.378	.016	11.51
L–51	55.78	3.05	......	.63	.57	.340	3.062	.194	.004	12.43
L–52	42.16	22.50	......	......	......	......	......	......	......	......
L–53	49.99	11.50	......	1.08	.75	1.064	5.026	.143	......	......
L–54	47.43	7.85	......	......	......	......	......	......	......	......
L–55	36.014	16.76	......	6.70	.18	.125	.871	.202	.123	35.11
L–56	15.80	......	......	......	......	......	......	......	......	......
L–57	24.761	......	......	......	......	......	1.305	......	......	......

East Mines:—

East Mines, general.

L–58 Micaceous ore
L–59 Crystallized black ore
L–60 Aluminous ore
L–61 Brown hematite

L–62 Brown hematite
L–63 "
L–64 "
L–65 Paint from new shaft
L–66 Starry ankerite
L–67 Ankerite
L–68 White ore from kilns
L–69 Ditto
L–70 "
L–71 White ore
L–72 " "
L–73 " "
L–74 " "
L–75 " "
L–76 " "
L–77 White ore and ankerite, dark pearl gray
L–78 Ankerite and white ore, raw
L–79 Ditto

East Mines, Slack hill.

L–80 Sample brown hematite from sheds
L–81 Ditto
L–82 White ore and ankerite; red color
L–83 Average of 9 samples, white ore and ankerite

Folly mountain.

L–84 Limonite
L–85 Brown ore; sp.g. 3.53
L–86 White ankerite

Pine brook.

L–87 Brown hematite

Totten lot and hill.

L–88 Sample of workings; ankerite and specular ore
L–89 Average of specular ore, calcareous limonite and ankerite
L–90 Dark brownish red limonite; sp.g. 3.20
L–91 Calcareous brown hematite
L–92 Ditto
L–93 Average of 9 samples ore
L–94 Limestone ore
L–95 Ditto
L–96 Red ankerite
L–97 Ditto
L–98 White ore and ankerite
L–99 Average ditto

Anal. No.	Fe	SiO_2	Insol.	Al_2O_3	CaO	MgO	MnO_2	P	S	Vol. matter
L–58	69.85	.13	......	......	.02	trace	trace	trace	.11	......
L–59	59.4	3.4	......	......	......	......	......	......	......	......
L–60	59.1	3.40	......	......	......	......	......	......	......	......
L–61	41.25	9.66	......	......	......	......	......	......	......	27.76
L–62	50.62	7.90	......	......	......	......	......	......	......	......
L–63	32.5	42.30	......	......	......	......	......	......	......	......
L–64	41.38	27.68	......	......	......	......	......	......	......	......
L–65	51.73	11.20	......	......	......	......	......	......	......	......
L–66	7.344	.33	......	......	39.038	5.746	1.928	......	......	......
L–67	13.45	......	......	......	......	......	......	......	......	......
L–68	11.54	......	......	......	......	......	......	......	......	......
L–69	12.50	......	......	......	......	......	......	......	......	......
L–70	12.90	......	......	......	......	......	......	......	......	......
L–71	31.37	1.20	......	......	......	......	......	......	......	37.62
L–72	33.67	.20	......	......	......	......	......	......	......	37.00
L–73	30.48	1.00	......	......	......	......	......	......	......	36.90
L–74	31.9	......	......	......	......	......	......	......	......	37.90
L–76	30.1	......	1.50	......	......	......	......	......	......	37.90
L–77	32.808	.53	......	......	1.49	12.221	1.425	......	......	......
L–78	26.94	......	......	......	......	......	......	......	......	33.56
L–79	10.62	3.40	......	......	43.60	21.250	......	......	......	......
L–80	40.91	12.70	......	......	......	......	3.207	......	......	6.84
L–81	......	16.02	......	......	......	......	......	......	......	8.26
L–82	29.06	trace	......	......	......	......	......	......	......	......
L–83	25.25	......	......	6.00	16.10	3.250	1.510	.033	......	40.60
L–84	58.68	.52	......	......	.52	.620	2.501	trace	.040	11.25
L–85	54.44	6.93	......	.21	.20	.120	1.427	.119	.012	13.33
L–86	14.352	.63	......	......	28.482	11.918	.540	......	......	......
L–87	41.25	.90	......	......	21.24	.939	......	......	......	......
L–88	46.73	......	11.97	3.90	5.05	.800	1.891	......	......	10.24
L–89	39.08	......	5.48	......	12.26	2.100	1.659	......	......	18.04
L–90	48.91	.07	......	tr.	11.70	0.420	2.25	none	.016	7.07
L–91	12.25	.20	......	tr.	21.28	4.410	......	......	......	......
L–92	14.97	1.70	......	......	28.28	4.970	......	......	......	......
L–93	26.45	......	3.00	3.77	22.90	2.880	1.81	trace	......	......
L–94	12.20	.05	......	......	......	......	......	......	......	......
L–95	12.20	.15	......	......	......	......	......	......	......	......
L–96	14.53	.30	......	......	......	......	......	......	......	......
L–97	15.39	.50	......	......	......	......	......	......	......	......
L–98	23.75	.50	......	......	......	......	......	......	......	40.00
L–99	30.63	3.36	......	8.37	21.97	15.00	1.470	.008	.023	5.89

Current values.—It is of interest to record the values of iron and insoluble matter in the furnace runs for the last few months.

General brown ore (paint, and any small amounts of specular and bottle ore) averages:—

Anal. No.		Fe	Insol.
	1906		
L-100	Jan.	39.12	23.84
L-101	Feb.	37.04	22.43
L-102	Mar.	40.15	22.10
L-103	Apr.	40.04	20.92
L-104	May	41.41	20.56
L-105	June	40.00	21.04
L-106	July	42.03	20.18
L-107	Aug.	40.09	18.76
L-108	Sept.	40.55	21.43
L-109	Oct.	43.65	18.07
L-110	Nov.	42.51	17.08
L-111	Dec.	42.57	16.99
	1907.		
L-112	Jan.	42.10	17.12
L-113	Feb.	43.60	16.89
L-114	Mar.	41.66	13.28
L-115	Apr.	45.22	15.33
L-116	May.	41.11	17.33

Derry hematite:—

Anal. No.		Fe.	Insol.
	1906.		
L-117	Sept.	41.05	25.60
L-118	Oct.	40.51	29.44
L-119	Nov.	40.00	29.43
L-120	Dec.	38.38	33.00
	1907.		
L-121	Jan.	34.20	38.21
L-122	Feb.	37.10	36.81
L-123	Mar.	39.86	24.39
L-124	Apr.	38.59	18.21

General carbonates (ankerite and siderite are not separated):—

Anal. No.		Fe.	Insol.
	1906.		
L-125	Jan.	14.41	5.48
L-126	Feb.	14.14	6.63
L-127	Mar.	15.21	4.39
L-128	Apr.	15.01	5.36
L-129	May	14.03	3.99
L-130	June	14.44	4.19
L-131	July	13.78	3.83
L-132	Aug.	13.24	4.05
L-133	Sept.	13.43	3.97
L-134	Oct.	15.01	4.25
L-135	Nov.	15.61	4.00
L-136	Dec.	14.19	4.04
	1907.		
L-137	Jan.	15.32	3.72
L-138	Feb.	14.92	3.21
L-139	Mar.	13.63	4.19
L-140	Apr.	15.33	3.48
L-141	May.	14.39	3.37

Other averages for May, 1907, the latest month for which statistics were procured for this volume, are:—

Anal. No.		Fe.	Insol.
L-142	Old Mt. brown	42.06	16.79
L-143	Old Mt. carbonate	15.17	2.09
L-144	East Mines carbonate	14.91	4.59

Yearly averages, 1906:—

Anal. No.		Fe	Insol.
L-145	Gen. brown	40.72	20.20
L-146	Old Mt. brown	43.07	16.94
L-147	Derry ore	39.98	29.37
L-148	Gen. carbonate	14.37	4.31
L-149	Old Mt. carbonate	14.38	3.83
L-150	East Mines carbonate	16.63	4.21

Maxima and minima, 1906:—

Anal. No.		Fe.	Insol.
L-151	Gen. brown, max.	41.85	25.19
L-152	" " min.	30.48	7.20
L-153	Gen. carb., max.	17.14	9.02
L-154	" " min.	10.71	1.70

Maxima and minima, 1907:—

Anal. No				Fe	Insol.
L–155	Gen. brown	Jan.	max.	49.80	25.12
L–156	Ditto	"	min.	37.01	8.92
L–157	"	Feb.	max.	53.50	20.65
L–158	"	"	min.	40.20	11.52
L–159	"	Mar.	max.	40.46	13.04
L–160	"	"	min.	30.01	7.83
L–161	"	Apr.	max.	52.43	20.70
L–162	"	"	min.	38.17	8.27
L–163	"	May	max.	51.00	16.45
L–164	"	"	min.	36.94	9.57
L–165	Derry hem.	Jan.	max.	33.80	40.10
L–166	Ditto	"	min.	31.80	36.63
L–167	"	Mar.	max.	28.29	.....
L–168	Gen. carb.	Jan.	max.	23.10	10.17
L–169	Ditto	"	min.	11.00	1.82
L–170	"	Feb.	max.	21.10	9.13
L–171	"	"	min.	11.87	1.47
L–172	"	Mar.	max.	14.34	3.87
L–173	"	"	min.	11.62	1.75
L–174	"	Apr.	max.	18.19	5.68
L–175	"	"	min.	13.16	2.61
L–176	"	May	max.	19.08	21.24
L–177	"	"	min.	11.94	1.95
L–178	Old Mt. brown	Jan.	max.	49.00	18.46
L–179	Ditto	"	min.	35.90	8.07
L–180	"	Feb.	max.	46.10	21.24
L–181	"	"	min.	40.60	5.35
L–182	"	Mar.	max.	43.03	18.00
L–183	"	"	min.	32.47	5.85
L–184	"	Apr.	max.	52.23	20.92
L–185	"	"	min.	40.59	9.89
L–186	"	May	max.	43.48	22.08
L–187	"	"	min.	40.26	9.09
L–188	Old Mt. carb.	Jan.	max.	14.10	4.12
L–189	Ditto	"	min.	11.10	1.16
L–190	"	Feb.	max.	23.10	10.17
L–191	"	"	min.	11.10	1.82
L–192	"	Mar.	max.	15.98	7.30
L–193	"	"	min.	11.15	1.43
L–194	"	Apr.	max.	19.26	4.92
L–195	"	"	min.	11.23	2.25
L–196	"	May	max.	17.49	6.50
L–197	"	"	min.	12.66	1.60
L–198	East Mines carb.	Jan.	max.	16.50	4.00
L–199	Ditto	"	min.	13.40	1.50
L–200	"	Feb.	max.	17.30	3.73
L–201	"	"	min.	12.50	1.83
L–202	"	Mar.	max.	18.86	5.12
L–203	"	"	min.	14.42	1.38
L–204	"	Apr.	max.	19.69	4.92
L–205	"	"	min.	12.84	2.25
L–206	"	May	max.	19.08	6.02
L–207	"	"	min.	12.13	2.91

General chemical considerations.—The percentages of ingredients have been given in the above portions of the chapter chiefly with reference to geographical location. The following takes up additional analyses, with which many of those which have gone before can also be used, showing the qualities of varieties of ore as such. Here and there is a stray geographical reference.

General red hematites:—

Anal. No.	Fe.	SiO_2	Insol.	Al_2O_3	CaO	MgO	MnO_2	P	S	Vol. matter
L–208	61.05	2.71	......	......	trace	.45	.63	......	......	8.01
L–209	59.10	3.50	......	......	.92	trace	......	......	1.26	5.20
L–210	48.00	16.40	......	6.09	2.44	1.05	1.22	1.13	none	.85
L–211	29.12	......	3.73	trace	trace	.65	.70	trace	......	10.18

The purer earthy red hematite of Old Mountain has a composition nearly like that of goethite (Fe_2O_3, H_2O). It also contains much less SiO_2 and P_2O_5 than any of the brown ores.

Rogers red hematite:—

Anal. No.	Fe.	SiO_2	CaO	MgO	MnO_2	P
L–212	47.20	18.34	trace	1.477	1.013	.061
L–213	52.82	13.15	......	......	......	......
L–214	52.87	13.15	......	......	......	......
L–215	62.87	1.57	......	......	......	......
L–216	53.76	18.62	......	......	......	......
L–217	49.80	18.03	......	......	......	......
L–218	61.24	11.69	......	......	......	......
L–219	58.61	12.89	......	......	......	......
L–220	44.23	27.17	......	......	......	......
L–221	44.52	22.70	......	......	......	......
L–222	50.70	16.00	......	......	......	......
L–223	54.07	8.02	......	......	......	......
L–224	44.80	19.90	......	......	......	......
L–225	47.12	12.57	......	......	1.460	......
L–226	47.63	14.12	.640	.740	......	......
L–227	45.00	17.80	......	......	......	......
L–228	47.81	17.70	......	......	......	......
L–229	46.53	18.80	......	......	......	......
L–230	46.72	16.14	......	......	......	......
L–231	43.30	18.80	......	......	......	......
L–232	40.90	25.42	......	......	......	......
L–233	40.50	22.48	......	......	......	......
L–234	40.20	22.35	......	......	......	......
L–235	48.834	16.731	......	......	......	......

These analyses began June 6, and were made from furnace charges up to October 30, 1906; at which time use of the ore ceased, owing to the fact that the carbonates were becoming a large part of the ore.

Derry hematite:—

Anal. No.	Fe	SiO_2	Al_2O_3	CaO	MgO	P	S
L–236	35.64	45.39	1.37	......	.11	......	.48
L–237	41.05	25.60	......	.693	......	.021	2.90
L–238	41.17	25.18	......	......	......	......	3.08
L–239	42.30	27.10	......	......	......	......	......
L–240	43.00	26.35	......	......	......	......	......
L–241	43.20	29.21	......	......	......	......	2.75
L–242	36.65	32.49	......	......	......	......	2.88
L–243	37.00	30.87	......	......	......	......	2.76
L–244	43.20	23.82	......	......	......	......	......
L–245	39.00	31.00	......	......	......	......	......
L–246	51.00	19.00	......	......	......	......	......
L–247	39.00	30.02	......	......	......	......	2.68
L–248	43.12	26.70	......	......	......	......	2.91
L–249	38.70	32.45	......	......	......	......	3.07
L–250	41.002	29.941	......	......	......	......	2.39

Use of the Derry ore has ceased, owing to its low iron and increasing silica, and to the prohibitive sulphur content. It is evident, from the bore-hole and chemical analyses, that this ore body gradually passes into rock downward and at a depth scarcely below drainage level.

Specular ore:—

Anal. No.	Fe	SiO_2	Al_2O_3	CaO	MgO	MnO_2	P	S	Vol. matter
L-251..........	69.11	.23	none	.66	none	none	trace	.32	......
L-252..........	69.81	.58	....	......	......	......	......	......	trace

Limonite (including bottle or hard black ore, general brown and paint or ochre):—

L-253 "Ore as lustrous botryoidal or mammillary and stalactitic masses, dark-brown colour, fibrous structure when broken."

L-254 Pure specimen of brown hematite.
L-255 Brown hematite.
L-256 Brown hematite, average sample.
L-257 Brown hematite, average sample, from ore sheds.
L-258 Ditto.
L-259 Ditto.
L-260 Brown hematite.
L-261 Brown hematite, sample from shed.
L-262 Brown hematite, yellow ochreous.
L-263 Paint from ore shed, light yellow.
L-264 Sample of paint; carbonaceous matter present.
L-265 Brown and coarse paint from ore shed.

Anal. No.	Fe	SiO_2	Insol.	Al_2O_3	CaO	MgO	MnO_2	P	S	Vol. matter
L-253...	59.31	....	2.67	.23	.14	.140	.28	.40	.004	11.40
L-254...	59.34	2.66	......	....	......	......	......	......	......	10.22
L-255...	58.25	3.75	......	....	trace	.650	1.83	......	......	10.18
L-256...	46.93	15.97	......	3.62	.44	.180	1.90	......	......	10.17
L-257...	33.06	12.68	......	.62	.55	trace	2.49	......	......	32.07
L-258...	40.35	16.01	......	.86	......	......	.88	......	......	23.11
L-259...	39.97	16.86	......	1.07	......	......	.56	......	......	26.55
L-260...	36.014	16.75	......	6.70	.18	.125	1.06	.46	.123	10.11
L-261...	....	15.64	......	....	......	......	......	......	......	9.36
L-262...	62.64	trace	......	....	......	......	......	......	......	10.55
L-263...	52.46	12.04	......	....	......	......	......	......	......	......
L-264...	49.80	trace	......	....	......	......	......	......	......	......
L-265...	43.60	25.30	......	....	......	......	......	......	......	......

White ore (siderite or sideroplesite, rarely pure):—

L-266 Sideroplesite.
L-267 Ditto.
L-268 Ditto.
L-269 Ditto, average of many analyses.

L-270 "White ore, pearl grey, in veinlets through ordinary siderite; appears to be sideroplesite."

L-271 Raw white ore.

L-272 Ditto, No. 2.

L-273 White ore with specular angular conglomerate.

L-274 Average of 18 samples, white ore and ankerite.

L-275 White ore and ankerite; average sample supplied to the furnace.

L-276 White ore and ankerite; granular cryptocrystalline in boulders.

L-277 Average sample of white ore and ankerite; West mine, one of upper levels.

Anal. No.	Fe	SiO_2	Insol.	Al_2O_3	CaO	MgO	MnO_2	P	Vol. matter
L-266.....	32.59	.43	......	......	.576	13.37	1.64	......	......
L-267.....	33.25	.47	......	......	.33	13.79	1.03	......	......
L-268.....	32.87	.25	......	......	1.76	12.49	1.56	......	......
L-269.....	32.71	....	......	......	1.08	13.47	1.40	......	......
L-270.....	33.10	.25	......	......	1.76	26.02	1.56	......	......
L-271.....	43.92	25.55	......	.67	....	....	....	.029	......
L-272.....	42.50	5.80	......	......	3.36	6.33	....	......	21.88
L-273.....	24.55	1.00	......	......	....	....	....	......	......
L-274.....	....	1.34	......	.24	28.34	26.01	.79	......	......
L-275.....	....	.19	......	......	30.68	21.42	.97	......	......
L-276.....	22.12	....	.31	......	15.41	11.42	1.71	......	......

Ankerite:—

L-278 White ankerite, pure.

L-279 Ditto.

L-280 Brown ankerite, pure.

L-281 White cryptocrystalline ankerite.

L-282 White scalenohedral crystals, ankerite.

L-283 Ditto.

L-284 White ankerite.

L-285 Ditto, streaked.

L-286 Yellow ankerite.

L-287 Pale brown, compact ankerite; Sp. g. 3.004

L-288 Brown ankerite.

L-289 Ditto.

Anal. No.	Fe	SiO_2	Insol.	CaO	MgO	MnO_2	P
L-278..................	11.18	.57	......	29.94	10.31	.58	......
L-279..................	11.10	.12	......	27.62	12.62	.51	......
L-280..................	10.89	.19	......	30.78	10.28	.97	......
L-281..................	7.88	......	.53	39.89	4.48	1.99	......
L-282..................	....	......	......	50.79	1.95	1.12	......
L-283..................	....	trace	......	....	.27	2.08	......
L-284..................	22.34	.50	......	30.24	10.56	....	......
L-285..................	11.44	.04	......	29.18	11.02	....	......
L-286..................	22.57	......	......	24.53	14.78	.6	.035
L-287..................	11.90	.06	......	26.90	12.44	.81	......
L-288..................	18.86	.13	......	28.90	13.73	....	......
L-289..................	19.54	......	......	27.55	14.50	....	......

Special occurrences:—

L-290 Week's average, calcined ore from kilns.
L-291 Ditto.
L-292 Average sample calcined ore from kilns.
L-293 White ore and ankerite, calcined, from kilns.
L-294 Ditto.
L-295 Roasted spathic ore.
L-296 Roasted white ore, Mr. Jamme's sample No. 3.
L-297 Brown hematite; Ferguson's paint.
L-298 Ditto; Ferguson's ore.
L-299 Ditto.
L-300 Ditto.
L-301 Ditto, paint.
L-302 Ditto.
L-303 Brown hematite; Langil's ore.
L-304 Sample from working opposite old charcoal furnace.

Anal. No.	Fe	SiO_2	Al_2O_3	CaO	MgO	MnO_2	P	S	Vol. matter
L-290...	28.00	3.50	9.47	9.41	23.59	2.26	......	......	....
L-291...	25.00	4.45	10.00	15.99	4.17	2.34	.110	.11	15.09
L-292...	30.625	3.36	8.37	12.30	15.00	1.10	.10	......	5.89
L-293...	33.50	......	....	....	....	....	......	......	6.28
L-294...	22.50	3.70	....	....	....	....	......	......	32.79
L-295...	21.74	21.50	2.17	....	....	....	.014	......	....
L-296...	50.65	......	....	4.56	.30	....	......	......	4.04
L-297...	50.99	6.30	....	....	....	....	......	......	....
L-298...	49.17	10.00	....	....	....	....	......	......	....
L-299...	41.56	20.70	....	....	....	....	......	......	....
L-300...	40.05	9.80	....	....	....	....	......	......	....
L-301...	37.22	28.17	....	....	....	....	......	......	....
L-302...	36.86	32.80	....	....	....	....	......	......	....
L-303...	48.21	16.80	....	....	....	....	......	......	....
L-304...	30.66	......	....	....	....	....	......	......	36.00

A small number of Mines Branch analyses are appended:—

55. Chiefly Old Mountain; ankerite stock pile at furnace; some siderite mixed.

56. Old Mountain and East Mines, especially latter; siderite stock pile at furnace, with some ankerite; general sample of coarse lumps.

57. Same as 56, but fine lumps.

58. Old Mountain brown ore, paint and fine lump limonite; stock pile at furnace.

59. Like 58, but coarse lumps with some specular and carbonate.

60. Rogers pit; general sample of No. 1 ore at furnace.

	No. 55	No. 56	No. 57	No. 58	No. 59	No. 60
Fe........................	14.80	14.80	15.84	39.20	39.82	43.62
SiO_2........................	2.16	4.58	1.36	....	....	....
Al_2O_3........................	.10	.11	.06	....	....	....
CaO........................	24.16	24.05	25.05	....	....	....
MgO........................	12.18	10.01	12.05	....	....	....

CHAPTER 6

PARTIALLY BEDDED ORES OF ARISAIG AND MALIGNANT COVE.

Contents of Chapter 6.

Location and extent.—The Arisaig iron field is situated in northern Antigonish county, on the shore of the Gulf of St. Lawrence (see Plates 49, 50). Beginning at Malignant cove and the Arisaig-Antigonish road, sometimes called the Gulf road, it stretches south-westward toward Merigomish and nearly parallel with the shore for five and one-half miles to a point south of Arisaig pier. Subsequent exploration may extend it somewhat farther in this direction (vid. Geol. Surv. Can., docs. 387, 388; Cape George sheet 33 and Antigonish sheet 34).

The chief portion of productive territory lies well up in the hills, one and one-quarter miles from the shore, and embraces an area at the utmost 10,000 by 1,000 feet. The remainder of the ore lies in scattered localities.

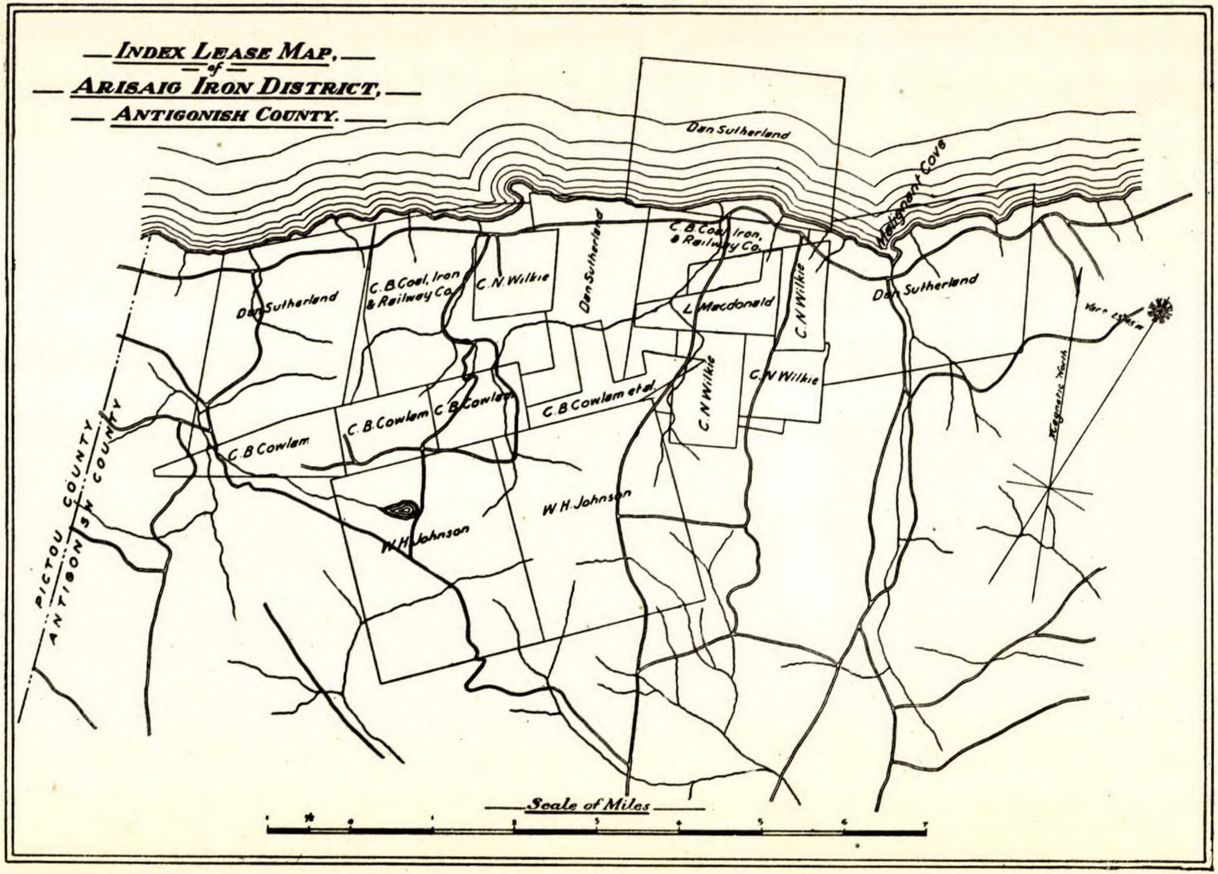
Topography.—The country south of the iron openings is part of the general plateau of northern Nova Scotia. The strike of the iron is roughly that of the shore to the north-west, and also that of the depression contours as one passes shoreward from the ore zone. The level of the plateau is about 550 feet. The highest point at which the iron is found is approximately 520 feet, practically at the summit of the plateau. This is at the south-west end. North-eastward the iron approaches the shore very obliquely, so that at this end the elevation along the iron-bearing zone is about 430 feet on the high land between the brooks.

The ore zone is at the brow of the elevated ground, and the profile thence seaward is in most places abrupt. At distances varying from three-quarters to one and one-half miles from the coast is a depression known as The Hollow, which also runs parallel with the shore. Outside of this the land again rises, but nowhere to such an elevation as inland. From the crest of the ridge thus formed the profile descends to the water with only a moderate slope.

The ore outcrops at altitudes of from 240 feet in East Branch to considerably over 500 at the highest pits on the upland. The small valleys of East Branch, Iron and McInnes brooks are practically ravines. But in places it would be politic, in any large scale operations, to tap the ore by adits at the lower level of Doctor brook itself.

Power and timber.—The chief stream of the immediate region is Doctor brook, and there is no other which gives any promise of furnishing power. The map will show that this brook has on the east East Branch, or as it is sometimes called, Campbell brook, and two other branches farther west—Iron brook and McInnes brook, upon which many of the iron openings are situated. These all have narrow valleys and steep descent. The valley of

PLATE 49.


INDEX LEASE MAP,
of
ARISAIG IRON DISTRICT,
ANTIGONISH COUNTY.
Dan Sutherland
C.B Coal, Iron, & Railway Co.
Malignant Cove
Dan Sutherland
C.B Coal, Iron & Railway Co.
C.N. Wilkie
Dan Sutherland
L. Macdonald
C.N Wilkie
Dan Sutherland
C.N Wilkie
C.N Wilkie
C.B Cowlam
C.B Cowlam
C.B Cowlam et al.
C.B Cowlam
W.H. Johnson
W.H. Johnson
Magnetic North
PICTOU COUNTY
ANTIGONISH COUNTY
Scale of Miles
1 2 3 4 5 6 7

the main stream, on the other hand, is for a long distance broad with a flat flood-plain bottom. At the Arisaig road, and for some hundreds of yards shoreward of it, the valley narrows, becoming a rocky gorge almost at the shore. While the stream is so small that at the dry season it is impossible to measure the horse power, it is capable by damming at the lower gorge of being converted into a reservoir a mile and a half long and half a mile wide in places, whose outlet would give a 40 foot head. Thus considerable power could be developed, even though the brook is normally not large.

South of the iron-bearing district, between Arisaig and the Intercolonial railway, is said to be a great abundance of hardwood of good size and quality. For a considerable distance from the iron property, however, what hardwood there is is culled growth. Enough of both hard and soft wood could be got for mine timbers, as not much is required; but for possible electric smelting it is not probable that good charcoal wood could be found, except at a distance.

Transportation.—Shipping could be conducted from Arisaig pier if necessary; but the coast is most unsheltered, and loading would be attended with some difficulties and even dangers. The water is not open throughout the year. There is no harbor, the whole coast being exposed to the gulf storms. A breakwater pier has been built at Arisaig, and does very well for small vessels. Undoubtedly some sort of shelter could be provided for barges and steamers of considerable tonnage at the pier. But on all this coast there is a strong longshore drift, tending to silt up any artificially formed embayments, so that a very expensive breakwater would only entail a large yearly outlay for dredging. The dead water inside of Arisaig pier shows at present this tendency to shoal up.

On the other hand rail transportation would be easy, if the country should ever be opened up on a large scale. A line has long since been surveyed from Antigonish north-west to Malignant cove, thence south-west through The Hollow, close to the iron ore openings and in the valley of Doctor brook, to Merigomish. From Malignant cove to Antigonish is 16 miles; to Merigomish 25 miles. The openings on East Branch would be two miles farther from the former and the same distance nearer the latter. The road would thus tap the Intercolonial at two points.

While the valleys of East Branch, Iron and McInnes brooks are steep, the first would not prohibit a spur line; and farther west the iron in large scale operations should be tapped from the main valley of Doctor brook, or at a low elevation up the side valleys, where such spurs as required would be feasible; or the ore could be run from the highland down to the railroad by gravity trams. Probably no other deposit in the province could be worked more conveniently without sinking than this one.

With the Pictou field as a smelting centre, rail transportation would not be costly. If Sydney or Sydney Mines received the ore, the expense would be greater.

Tenure of ore lands.—This is one of the very troublesome districts in which part of the iron minerals is reserved to the crown, and part, owing to the date or character of the land grant, is held with the land. The latter occurs in the so-called soldiers' grants. It appears to be difficult to keep track of the two classes of land, especially as the lease map at the Mines Office in Halifax covers all the territory in its leases. It is important to the investor to be able to distinguish between these classes; for in one case leases must be taken out at the Mines Office and a royalty of 5 cents per long ton paid into the provincial treasury upon all ore used. In the other case the investor must bargain with the owner of the land for the ore, and pays no royalty to the crown.

As well as can be ascertained, the following properties are soldiers' grants, and hold possession of the iron upon them:—Andrew Macdonald, John Macdonald, John McInnes, and Louis Gillis, the properties lying in a block, east to west, in the vicinity of McInnes brook.

History of Operations.

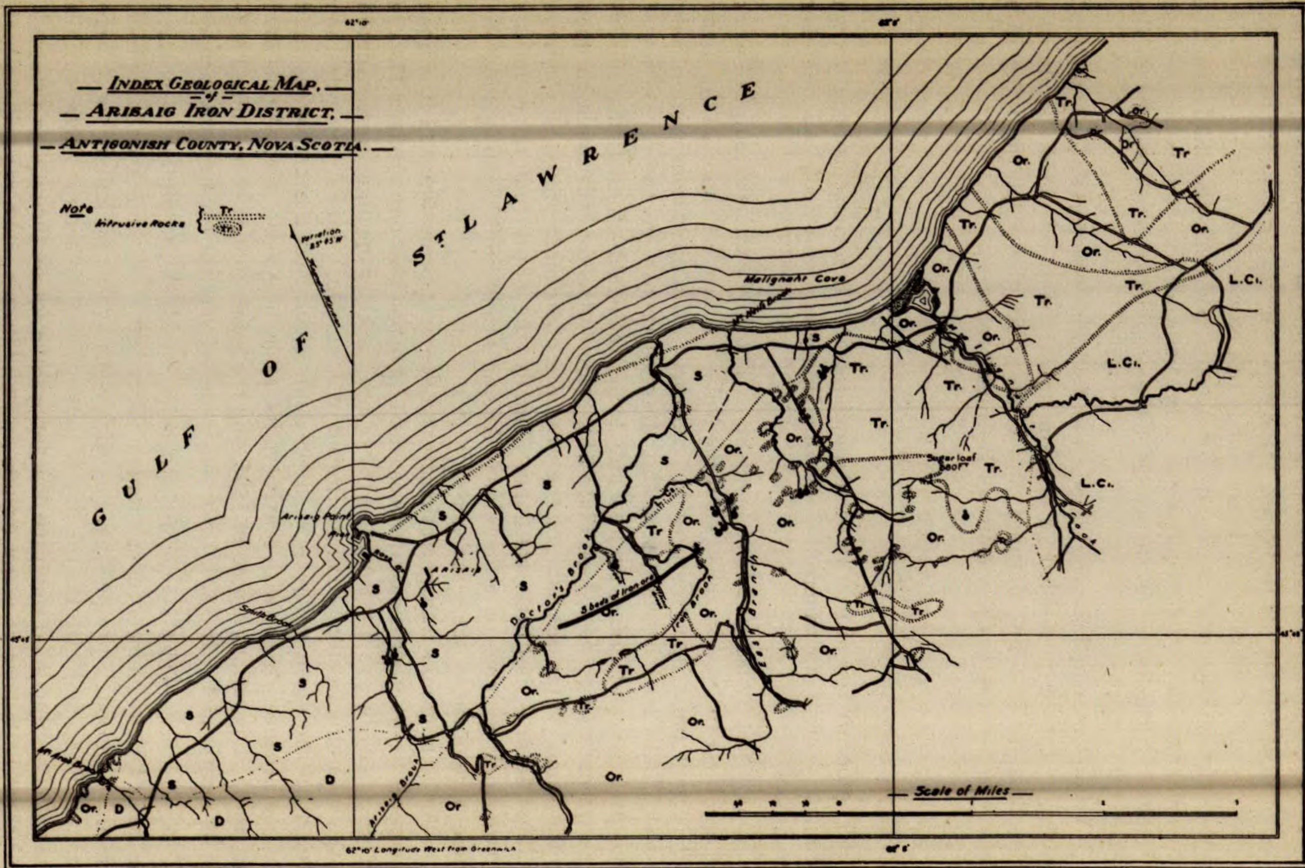
The occurrence of iron in some quantities in this region has been known for many years, being referred to by Drs. Honeyman and Poole, Mr. Fletcher and others.

Nova Scotia Steel and Coal Company.—The only serious attempt to work the ore, however, was in 1893, when the Nova Scotia Steel and Coal Company had certain parts opened up under contract. The operations were chiefly on the Tunnel lead, between Iron and McInnes brooks, on the properties of John McIsaac and Louis, Andrew and John McDonald—these four farms lying adjacent east to west, (see Plate 51). Some attempt was made to open up the same vein in the bank on the west side of McInnes brook, on the farm of John McInnes, but little was done. Finally, the Trunk road mine consists of two small openings on either side of Arisaig brook, in Silurian bedded ore. These were made by the same men.

The mining and transportation were alike most primitive, and it is open to conjecture whether the contractor could have received any profit. The ore was trammed by gravity from the hill where the chief openings were situated to the valley of Doctor brook south-east of John McDonald's. It was then hauled up the steep valley side to the high ground on the north-west and trammed thence, chiefly with gravity in its favor, to Arisaig pier. A pole road was used. Operations ceased in 1895, and the total amount of ore mined cannot be ascertained. In 1894, 1,376 tons were delivered at the Ferrona furnace.

Speculation.—This is one of the districts in which attempted speculation has spoiled many chances for sale and development. Without adequate proof, gained by thorough prospecting, but with considerable probability of a large amount of ore, and with the quality of much of the ore against them, various owners have demanded the price of a large mine for an incomplete prospect. And there have been so many owners and middlemen, each requiring a high percentage of profit, that the total cost of the district to the investor could not be other than exorbitant.

PLATE 50


Index Geological Map
of
Arisaig Iron District.
Antigonish County, Nova Scotia.
Note
Intrusive Rocks
Tr.
Gulf of St. Lawrence
Malignant Cove
Arisaig Point
Doctor's Brook
Iron Brook
Sugarloaf
Scale of Miles
S
D
Or.
Tr.
L.C.
62°10' Longitude West from Greenwich

General Geology.

Ordovician.—Three groups of rocks are represented in the immediate vicinity of the iron-bearing zone. The oldest is the Ordovician, occupying the high or inland country for the most part, but extending to the shore on the north-east at and near Malignant cove. The rocks consist of dark slates, sandstones and quartzites, and to the south of the iron-bearing belt a zone of red slates, useful for correlating the ore beds in the various parts of the field.

The structure of the rocks is somewhat irregular. Whether much close folding repeats the strata is not known with certainty, but several local folds are visible. The dips vary from north to south but are prevailingly in the north quadrants. The strike is quite erratic, varying by 30° within a few hundred feet; but as a whole it is from N. 45° E. to nearly E.-W. (magnetic) in the eastern part of the field, swinging to range from N. 80° E. to N.45° W. (magnetic) in the western part. Here, and throughout the description of Arisaig, magnetic readings are employed. The declination is approximately 23° 45′ W.

Silurian.—To the seaward of the Ordovician is a canoe-shaped synclinal basin of Silurian of various ages, occupying the shore portion as shown upon the general map. In this occurs the iron ores of Arisaig brook (Trunk road) and Ross brook a short distance to the east.

Eruptives.—The third class of rocks, most important in its effects upon the distribution of the iron ores, is the series of basic eruptive rocks. In the Silurian they are confined, so far as concerns this study, to the eastern portion of the field at Grant brook. But in the Ordovician they exert a great influence in the eastern part of the field, and are found to some extent in the western. South of the old tunnel workings of the Nova Scotia Steel and Coal Company, east of McInnes brook, they come in as green agglomerates and tuffs, apparently parallel with the stratification and probably contemporaneous with the beds; and lying immediately north of the red slates already referred to. At Iron brook these same agglomerates are closely connected with the southernmost iron ore beds. They do not, however, affect the distribution of the iron ore directly.

But toward the eastern end of the field, all about East Branch and thence eastward, are irregular masses of basic eruptives called diorites by earlier writers on the geology of the country. There are a few in Gillis and McInnes brooks to the west, but they appear not to affect the ore.

The exact distribution of these eastern eruptives has never been worked out. It is given in a general way upon the accompanying map; but in advance of any purchase of this part of the district, or of any plans for large scale development, the size, shape and exact distribution of the many trap bodies should be determined in detail. The reason is the practical certainty that these cut off the iron on the strike and the possibility that, in some cases at least, they may interfere with the continuity of the ore beds in depth.

Certain strata and eruptives along the shore between Doctor brook and Arisaig pier, unconnected with the economics of the region, are not considered here.

DESCRIPTION OF OPENINGS.

Scattered eastern occurrences.—On the property of Ronald McDonald a mile from Maligant cove, one-fourth of a mile west of the Antigonish or Gulf road and south-east of Sugar Loaf hill, is a small pit in bedded red hematite. Scattered pieces and two small outcrops trace the ore for perhaps 75 feet.

In the pit (No. 55) the hanging wall is a fine slate, well cleaved; the foot-wall, gray quartzite: strike N. 49° W., dip 75° S.W. The ore is fairly promising in appearance and not especially siliceous, breaks irregularly and gives a brownish red streak. It is 3 feet 2 inches in thickness, without rock partings or extra siliceous portions.

The rocks on this property are considered Ordovician. To the west and north, in the direction of the main iron ore field, a great mass of basic eruptives comes in, forming the high land and cutting off any ore found in the vicinity of the Antigonish road from that of the main field.

Rumors were abundant of more iron ores in this vicinity and north-east toward the shore beyond Malignant cove, but they could not be verified.

Sample 95 is a general cross-section test of the bed.

	No. 95
Fe.	43.62

On the western branch of Grant brook, the first stream west of Malignant brook, there are two openings on a very irregular vein of oölitic red hematite. The country rock is a decomposed, dark green trap. Two samples of ore, rather above the average of what would be obtained in the regular course of mining, gave:—

	No. 86	No. 88
Fe.	40.23	26.31

This occurrence is very limited in size and gives no promise of permanence.

Silurian ore beds.—Passing now to the extreme west end of the known iron-bearing field, a road leaves the Arisaig-Merigomish shore road near Arisaig pier and runs southward up the valley of Arisaig (or Trunk road) brook and across the mountain. The valley of this brook is for the most part a very narrow rocky gorge. At 2,000 feet up this road, in fissile slates


PROPERTY MAP,
ARISAIG IRON DISTRICT,
SHOWING GEOLOGY & ORE-PITS.
Scale of Feet.
SUGAR LOAF 680 FT
NORTHUMBERLAND STRAIT
LOCATED RAILWAY
DOCTOR'S BROOK
EAST BRANCH
GRANT BROOK
MCNEIL'S BROOK
GILLIS BROOK
PROFILE ON TUNNEL LEAD, 0 TO 46.
Tr.
Or.
S
LC1.
LC2.
W. J. Chisholm
Malignant Cove
Wm Ross
John H. McCallum
Colin Grant
Dan Grant
Peter Ross
Daniel Gillis
Flora McDonald
John A. McDonald
Robert Rudolph
John J. Ross
Church Property
Cemetery
Light House

PLATE 52.

(*a*) Open cut in Ankerite: East Mines, Londonderry.

(*b*) Pit No. 33, Arisaig, looking westward along foot wall.

PLATE 53.

(*a*) Pit No. 53, looking west.

(*b*) Pit No. 52, looking east.

standing perpendicularly, a bed of red hematite was cut on both the east and west sides of the brook (pits 52 and 53) and tested to some extent by the Nova Scotia Steel and Coal Company in 1893.

The cuts are run horizontally into the walls of the gorge for a few feet, leaving a roof overhead. The ore is identical in the two, being an easily broken, somewhat oölitic, fossil red hematite. Some calcite and quartz stringers are present in it. While varying in the immediate vicinity from 2 feet 6 inches down to 1 foot 6 inches, it is 2 feet in the cuts.

Sample 78 is from the north-east pit, and 79 from the south-west pit, both being taken across the vein.

	No. 78	No. 79
Fe	35.260	35.62
SiO_2	17.600	....
Al_2O_3	7.000	....
CaO	11.750	....
MgO	.420	....
P	.850	....
S	.019	....

Analysis of a shipment of ore by Mr. C. A. Meissner (A–2), a sample for the Dominion Iron and Steel Company (1902), gave:—

	A-2
Fe	52.930
SiO_2	11.620
Al_2O_3	7.460
P	.495

In the annual report of the Commissioner of Mines for Nova Scotia for 1874 occurs the statement, "At Arisaig, close to the pier, a bed of hematite three feet in thickness has been exposed." There is a tradition to the effect that ore can be seen at low water somewhere in the vicinity of the pier, but it is impossible to substantiate this. While the above reference may be to that reported occurrence, it is probably the Trunk road bed that is meant. No other is known, except on Ross brook, to be described next. In the N. S. Department of Mines report for 1875 the following analysis (A–3) is given for this ore:—

	A–3
Fe	52.34
SiO_2	16.10
CaO, MgO	8.76
MnO_2	trace
P	.37
S	trace

On Ross brook, a few hundred yards to the east and almost directly on the strike of the Trunk road openings, is a similar small tunnel in ore in the west bank (pit No. 54). The iron is in character like that already described. Where measured it gave a thickness of 2 feet 3 inches, the ore being clean and the walls very regular. It is said to thin to 1 foot on the east side of the brook in an opening now obscured.

Sample 80 is a general test of this ore.

	No. 80
Fe	46.000
SiO_2	18.630
Al_2O_3	8.700
CaO	2.700
MgO	.860
P	.700
S	.012

On Smith brook, some distance to the west of Arisaig, some of the older maps have iron marked, and Mr. Fletcher writes (Geol. Surv. Can., doc. 243) of "massive, maroon-colored argillite, which would seem to be a depauperated form of the iron ore band." Whatever else there may be, it was impossible to find any ore in the brook.

McKenzie veins.—Returning once more to the east, the iron pits and outcrops to be described lie in one general line on the edge of the upland. All are red hematite, with one exception, to be noted in its place. They are all in the Ordovician and probably represent approximately the same rock horizons throughout. But the McKenzie openings are separated from the beginning of the main iron ore field at East Branch by 3,200 feet, occupied in part at least by trap.

On the property of Duncan McKenzie iron ore occurs within 50 feet of the western land line and 6,180 feet south of the centre of the shore road. Thence east for several hundred feet are intermittent outcrops and openings. The relation of the various exposures is shown in the map. While pit No. 35 is the westernmost opening, the bed can be traced for at least 200 feet farther west by drift.

Pit No. 32 is the easternmost one on the property. Ore has not been traced eastward from this for any distance, but can be followed for at least 300 feet west, with a somewhat sinuous strike. The thickness of the ore is variable, averaging 2 feet 10 inches. Both walls are of gray quartzite, the hanging wall greenish and somewhat slaty and decayed. The ore is extremely siliceous to within 9 inches of the latter, the hanging wall portion being of better grade. The strike varies from N. 83° E. to N. 88° W., averaging E.-W. The hanging wall dips 63° N., the foot-wall 40° N., so that the vein is here pinching downward. Sample 89 is a general section of the cut, excluding three inches on the south wall.

Close to this opening, on the west, is a natural outcrop from which about 500 lbs. have been gathered into a small dump. Sample 97 is a general one of this dump, the ore of which is very coarse.

	No. 89	No. 97
Fe	21.21	32.81

No. 33 pit is the main opening. Here for 64 feet the ore is exposed continuously, partly by natural outcrop, partly by excavation, and has been broken out to some extent for 46 feet. The strike at the east end is N. 75° E.; at the west end, N. 80° E., and the dip 62° N. The bed varies in width considerably, but not abruptly. Thus, 15 feet from the east end it is six feet, while at 21 feet it is reduced to four. The average thickness is 3 feet 8 inches.

The foot-wall is a dense and hard bluish gray quartzite, weathering white. The hanging wall is not very distinct, but is a decayed siliceous slate, softer than in the east opening and full of cavities left by the decay of pyrite. The ore near the foot-wall is dark gray and highly siliceous. At the distance of a foot it becomes reddish and finely oölitic, and gives a reddish brown streak; and it continues good in appearance and with a regular fracture up to the hanging wall. Many fossil shells are present.

The bed, which is locally called the McKenzie lead, can be connected directly with the east opening by small natural outcrops.

Sample 90 was taken for 40 feet along the strike of the bed in this opening. No. 96 is a general test of about 600 lbs. of ore on a dump at the west end of the long opening.

	No. 90	No. 96
Fe	29.51	44.00

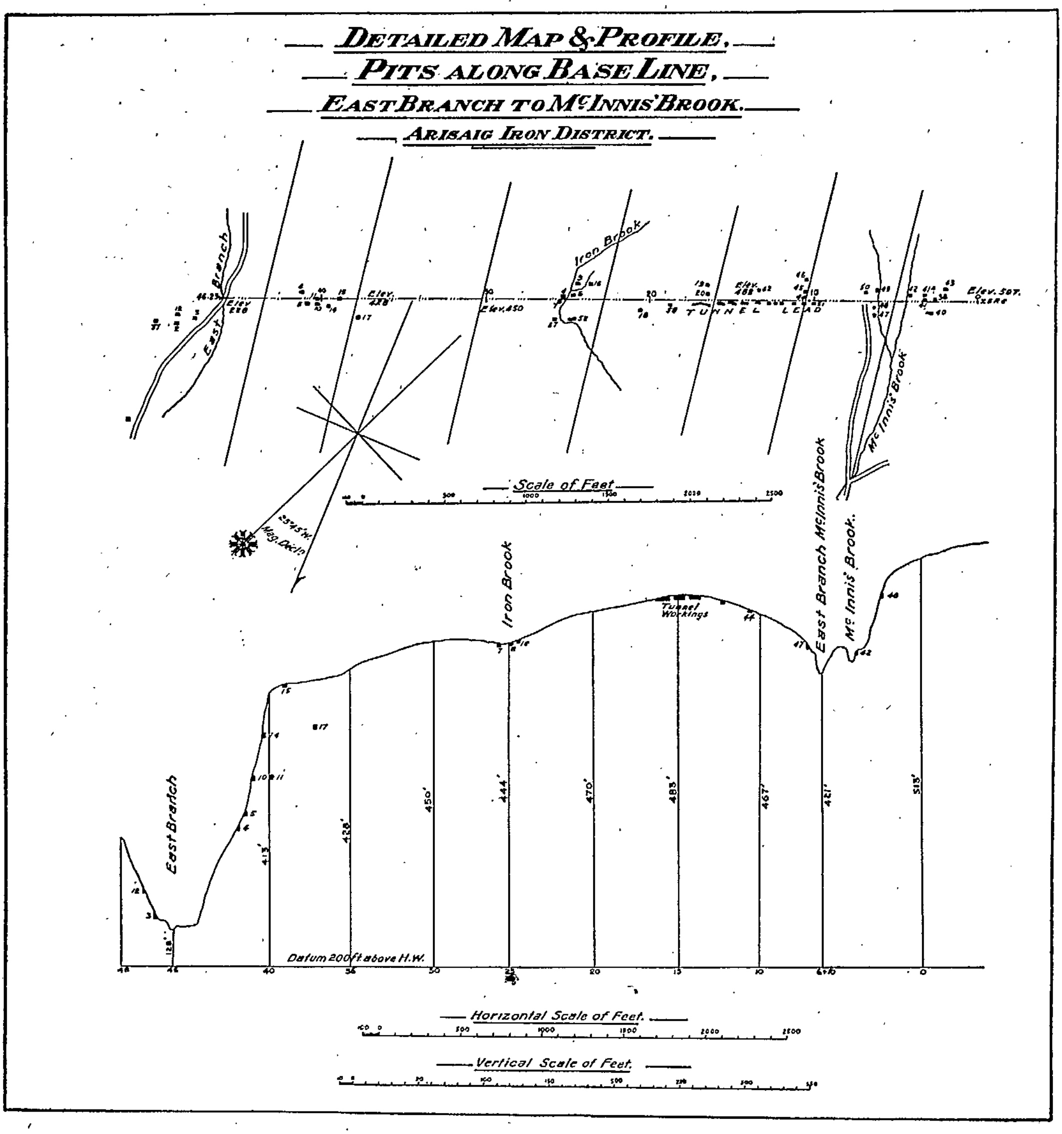
Pit No. 35 is a long exposure, near the west property line of Duncan McKenzie, part natural and part artificial, and belonging to the same ore bed as the two previously described. The character of the opening precluded accurate measurement of the thickness.

Pit 34 is a shallow excavation, on a vein some 27 feet south of the McKenzie lead, behind pit No. 33. The ore is here coarse and very siliceous. Two analyses, No. 98 of the ore from the vein, and No. 99 of ore from a small dump, gave:—

	No. 98	No. 99
Fe	28.42	24.22

No more iron ore is known east of East Branch. The country is cut by several trap intrusions, and apparently also is faulted in at least one

PLATE 54.


DETAILED MAP & PROFILE,
PITS ALONG BASE LINE,
EAST BRANCH TO M^C INNIS' BROOK.
ARISAIG IRON DISTRICT.
East Branch
Iron Brook
TUNNEL LEAD
M^c Innis' Brook
Elev. 450
Scale of Feet
Mag. Dec'n
Iron Brook
Tunnel Workings
East Branch M^c Innis' Brook
M^c Innis' Brook
East Branch
Datum 200 ft above H.W.
Horizontal Scale of Feet
Vertical Scale of Feet

place, with a considerable lateral displacement. It is, on the whole, unlikely that ore so far east will be found persistent for any great distance.

East Branch, Doctor brook.—On the east side of this stream are five pits, numbered in order up-stream 1, 37, 2, 12, and 3, on the property of Peter Ross. The excavations made in this area are not encouraging, from the standpoint of quality or probable permanence of the deposits. The ore is very siliceous, in bands varying from a few inches to five feet, interbedded with quartzites, one of the walls being often slaty in character.

Analyses of the ores from the different pits gave the following results:—

	No. 61	No. 100	No. 196	No. 101	No. 62	No. 73	No. 102	No. 63
	Pit No. 1			Pit 37	Pit 2	Pit 12		Pit 3
Fe.	29.70	37.37	27.18	26.32	38.82	37.09	40.09	25.81

West of the brook there are eight pits, numbered respectively 13, 17, 5, 10, 14, 4, 11, and 15. Of these 13 is on the land of Peter Ross, and shows a bed of highly siliceous oölitic ore, some 10 feet wide, with an intervening band of one foot of quartzite. The bed dips 42° N.W., and lies between slate and quartzite. Sample No. 106 was selected from a 6 ton dump of ore.

	No. 106
Fe.	39.10

Pit 17 is on the farm of Angus McIsaac, and shows 4 feet of solid ore between quartzite and slate. The bed appears to be regular, but very little work has been done here. Sample 94 was taken across the bed.

	No. 94
Fe.	24.02

Pits 5, 10, 14, 4, 11, and 15 constitute a series of excavations which lie between pits 13 and 17. They are situated on the land of Ronald McInnes, close to the base line surveyed a few years ago by P. S. Archibald, C.E. The distance between the extreme pits is about 250 feet. Although all these are comparatively close together, it is not possible to correlate the various ore veins exposed, which vary from very narrow to some 10 feet. The ore, as a rule, is very siliceous, and mixed with stringers and druses of quartz. The walls are sometimes quartzitic, sometimes slaty.

Samples 65, 66, and 103 are from different parts of pit No. 5.

Sample 104 is ore selected from a 4-ton dump, near pit No. 10.

Sample 105 is a selected one from a 20-ton dump, near pit 14.

Sample 64 is of one taken across the vein, in pit No. 4.

Sample 71 is from pit No. 11, and sample 76 is an average of ore from pit 15.

	No. 65	No. 66	No. 103	No. 104	No. 64	No. 71	No. 76
Fe.	39.23	36.41	38.91	39.52	25.29	34.97	40.07

	No. 105
Fe	46.380
SiO_2	23.560
Al_2O_3	4.830
CaO	1.650
MgO	.220
P	.715
S	.012

Chemistry of East Branch ores.—Of 54 samples taken from the district in 1900 by Mr. P. S. Archibald, C.E., record of analyses of 19 can be found. They all seem to have been analysed by Dr. Hoffman, for the Geological Survey, Mr. R. E. Chambers, for the Nova Scotia Steel and Coal Company, and Mr. D. J. Pinkerton, for the Dalzell Iron and Steel Works, of Motherwell, England. What pits are represented in these, it is difficult to say, as all references are to survey stations; but it is certain that some comparatively recent openings were not available.

The samples referred to East Branch are four, as follows, the numbers referring to those used in reports by the gentlemen named:—

		Fe	SiO_2	P	S
	No. 6				
A–77	Hoffman	42.55	28.65	....	....
A–78	Pinkerton	41.81	30.00	.228	trace
A–79	Chambers	42.79	....	....	....
	No. 13				
A–80	Hoffman	42.39	29.73	....	....
A–81	Pinkerton	47.97	24.20	.660	trace
A–82	Chambers	42.90	....	....	....
	No. 14				
A–83	Hoffman	39.81	34.91	....	....
A–84	Pinkerton	31.98	43.00	.960	trace
A–85	Chambers	44.20	....	....	....
	No. 15				
A–86	Hoffman	53.00	9.99	....	....
A–87	Pinkerton	35.67	44.00	.312	trace
A–88	Chambers	34.78	....	....	....

PLATE 55.

(*a*) Pit No. 13, looking south-west.

(*b*) Specimen of kidney ore, from Tunnel vein.

Averaging these the following results are reached:—

		Fe	SiO_2	P	S
A-89	Hoffman, numerical aver.	44.475	25.813	....	....
A-90	Hoffman, re-analysis	44.750	25.760	.840	.008
A-91	Pinkerton	39.358	37.800	.555	trace
A-92	Chambers	41.170	....	....	....

Two samples, taken by C. A. Meissner, M.E. for the Dominion Iron and Steel Company in 1902, are given below. It is not possible to say with certainty which ore beds are referred to.

	A-93	A-94
	"6 ft. seam"	"4 ft. seam"
Fe	35.250	52.460
SiO_2	37.530	11.990
Al_2O_3	4.480	7.430
P	.926	.476

Iron brook.—Along Iron brook, on the land of Alex. McDonald, there are several excavations, numbered 6, 7, 8, 9, 16, 56, and an old shaft sunk by the Nova Scotia Steel and Coal Co., the position of which is given on the sketch map (Plate 51). The shaft was sunk on an isolated occurrence of the Tunnel lead, which here pinched out in all directions, and nothing can be learned from it at present.

Of the pits it is likely that 6 and 8 are on the same bed, which shows 12 feet of ore in one and 8 feet 8 inches at the other. The ore is very siliceous, as there are stringers and grains of quartz scattered through the bed. The wall on one side is slate, and on the other a rock which may be an altered tuff. On account of the coarseness of the ore and of the visible quartz grains scattered through the bed, it may be referred to as the Coarse lead.

Sample 67 was taken from across the bed in pit 6; sample 131 from the dump near it; sample 69 from the bed in pit 8, and 130 from the adjacent dump.

	67	131	69	130
Fe	34.95	30.31	34.95	41.90

Pits 9 and 16 are also thought to be on the Coarse lead, which at this point is faulted south. The strike is N. 84° E., and the dip is 82° N. A section here shows the following sequence:—

Ore	10′-0″
Slate	1′-0″
Ore	4′-0″
Total	15′-0″

Sample 70 is from across the bed exposed in pit No. 9; sample 129 comes from the dump; sample 77 is from bed in pit 16; samples 128 and 141 are from the dumps.

	70	129	77	120	141
Fe.	31.93	34.46	35.81	37.23	41.87

Pit No. 7 is on a bed of very siliceous ore, 3 feet 8 inches thick, including a 6 inch rock parting. The bed is between slate and quartzite.

Relations of Iron brook ore beds.—The structure of this part of the field is difficult to work out in detail, with so few exposures. But the character of the ore and walls in the various pits indicates great probability that but two horizons are represented in the pits already described, namely, the Coarse lead, and one which for convenience is hereafter designated as the Intermediate lead (pit No. 7). Both are traceable for some thousands of feet.

There is no resemblance between the ore in any of these pits and that in the openings on East Branch; and it has not been possible to make any correlation between the two valleys. What the character of the intervening ground is, whether the ore beds have been faulted or thinned out, cannot be decided without much more prospecting. It is certain, however, that on East Branch the ore is troubled by intrusions, and that on Iron brook it is dislocated by faults. From here westward there is less disturbance.

Chemistry of Iron brook ores.—Of the lot of samples mentioned in connexion with East Branch, Nos. 5, 7, 9, 10, 12, 16, 18, and 19 are noted as belonging to Iron brook. As far as can be discovered from the station readings accompanying the assay records, Nos. 5 and 10 are on the upland between Iron and McInnes brooks, in a locality where no iron is now known; and No. 9 is between Iron brook and East Branch, also where no bed is known at present. Of the rest, Nos. 7 and 16 are probably from pit 8, No.18 from pit 9, No. 19 from pit 16, and No. 12 from the old N. S. Steel and Coal Company shaft.

			Fe	SiO_2	P	S
A– 4	No. 7	Hoffman	47.56	25.47	. . . . . .	. . . . . .
A– 5		Pinkerton.	37.57	35.40	.459	trace
A– 6		Chambers.	46.25	. . . . . .	. . . . . .	. . . . . .
A– 7	No. 12	Hoffman.	59.89	8.09	. . . . . .	. . . . . .
A– 8		Pinkerton.	38.78	32.00	.210	trace
A– 9		Chambers.	not given	. . . . . .	. . . . . .	. . . . . .
A–10	No. 16	Hoffman.	43.22	28.72	. . . . . .	. . . . . .
A–11		Pinkerton.	43.66	29.10	.624	trace
A–12		Chambers.	40.36	. . . . . .	. . . . . .	. . . . . .
A–13	No. 18	Hoffman.	51.22	20.59	. . . . . .	. . . . . .
A–14		Pinkerton.	47.00	32.00	.552	trace
A–15		Chambers.	48.17	. . . . . .	. . . . . .	. . . . . .
A–16	No. 19	Hoffman.	27.10	48.18	. . . . . .	. . . . . .
A–17		Pinkerton.	not given	. . . . . .	. . . . . .	. . . . . .
A–18		Chambers.	43.13	. . . . . .	. . . . . .	. . . . . .

Averages of these follow. The first of the two quoted from Hoffman includes Nos. 5, 9, 10, as well as those given above.

		Fe	SiO_2	P	S
A–19	Hoffman, re-analysis	45.300	26.330	.600	.003
A–20	" numerical average	45.775	26.210	....	....
A–21	Pinkerton (No. 19 not given)	41.753	32.125	.461	trace
A–22	Chambers (No. 12 not given)	44.228	....	....	....

Tunnel lead openings.—In Iron brook for the first time is found an ore bed which is characterized by certain peculiarities, and called the Tunnel or Kidney lead. As it is poorly developed in this brook, description of the ore can best be delayed a few paragraphs.

Pit No. 56 is merely a slight excavation in the bed of the brook, situated at a sudden bend of the stream. It shows iron ore three and one-half feet wide on the east side, but almost cut out four feet to the west, where it disappears into the bank. The south wall is a fine banded sandstone, in places really a quartzite. The north wall is a light grey slate. Both walls average N. 80° E. strike, and 75° N. dip. The ore is of the peculiar oölitic and pebbly appearing variety noted in the Tunnel lead farther west, but very much mixed with slate and evidently much compressed and disturbed. It was impossible to get a sample.

A short distance to the eastward, against the steep east bank, is an old shaft, filled in and with no ore around it. It was sunk by the Nova Scotia Steel and Coal Company, in the course of their prospecting for the Tunnel lead. Their engineer reports that it was a small local deposit, cut off on all sides. From memory, the ore is thought to have run 48 to 50 per cent iron.

These two openings have no direct economic importance, but indirectly they are of value. First, they show that a very easily distinguished deposit is continuous eastward for a long distance; second, that it is very likely not in workable condition so far to the east, and it would not pay to prospect especially for it east of Iron brook.

Inasmuch as the working of the Tunnel lead progressed from the west to the east, it will be easier for the moment to reverse the order of description that has been followed, and to run over the main openings on the lead, beginning on the west on the hill east of McInnes brook, at the point indicated on the map. (Plate 51).

The westernmost opening is a pit on John McDonald's property (No. 51) near its east line. The characteristics of ore and rock here, as in several other parts of the Tunnel openings, have been of necessity taken by description from those who worked in the open cuts. No ore was shipped from this pit, but a small amount broken out about the time of closing down of the works. The vein was struck on a turn or incomplete fault, the offset being to the right; that is, the west side moved north. The ore was narrow, but looked as good as the average. Sample 122 is a selected sample from the dump.

The next pit, the westernmost one on Andrew Macdonald's farm, had no ore shipped, but several hundred tons of iron ore were found in a rather weathered state on the dump. From a pit a short distance east, however, a considerable shipment was made. The thickness of the surface drift is 8 feet. There appears to be about 3 feet 6 inches of rather slaty ore, dipping 65°-70° N. Sample 121 was selected from the dump. Half-way between this and the shaft, in the first long trench (third trench in the series), is a small pit, said to have been opened the day the work was stopped on the property, and showing 3 feet 6 inches of slaty ore. None is visible now. In the shaft 5 feet of good ore was worked. Sample 123 was selected from ore lying on the dump beside the trench from this shaft to the east line of Andrew Macdonald's farm.

About 25 feet east of the first shaft the lead pinches, swelling to 8 feet at the second shaft, 25 feet farther; pinching once more 20 to 25 feet to the east. It swells at the second shaft to 8 feet in places. In pinching the hanging wall remains even, the foot-wall coming in at a lower dip than normal. This holds true, whether the pinch be a flat one below, or a steep or vertical one longitudinally. Fifty feet from Andrew Macdonald's east line the ore meets a perpendicular left-handed break or fault, with an offset of 7 feet. In the segment between this and the property line the ore is fair, averaging 3 feet 6 inches. Near the fault it is narrower.

From the boundary between the properties of Andrew and Louis Macdonald, sample 124 was selected to the end of the chain of trenches. Immediately east of the farm line another left-handed fault is encountered, with an offset of 17 feet. Beyond, the bed is continuous to the end of the trench. At the east end the ore is said to have begun at 24 inches at the surface, widening to 5 feet 6 inches at a depth of 20 or 22 feet. At 25 feet depth an almost flat fault cut the ore off completely, curving somewhat, at the east having a dip of about 40° W., and flattening rapidly westward. It is not known which way the rock shifted. At the end of the trench the ore ended. While men who worked in the trench call the interruption a break, questioning brought out the fact that the ore stopped against rock, with a roughly convex ending. It is impossible to prove the exact nature of the change, but it may be an interruption in the replacement. Eastward 123 feet and a few feet to the north, the Tunnel lead has again been cut in a pit (No. 58), but no work was ever done upon it, and no information is obtainable, except regarding the character of its ores. Evidently there is faulting between these two exposures, as the pit is 20 feet north of the line of eastward prolongation of the last trench.

Between this pit and Iron brook, a distance of 800 feet, no openings have been made on the Tunnel lead.

Tunnel lead ore.—While the iron ore of this bed is locally called kidney ore, it is quite unlike the botryoidal variety usually named kidney, and in some places bottle ore; that being mammillary, fibrous and concentric limonite, while this is a red hematite, copper brown in surface colour, and with a bright red streak or powder.

The ore is in two conditions. The first is a rather coarse oölitic form, in masses which bear a remarkably close resemblance to pebbles, whatever may be their real origin (See Plate 55, fig. b). These range from a small nut size to that of a large egg, and their iron appears to be very pure. The pebbles, or kidneys, have little alignment in the bed as a whole.

The remainder of the belt is taken up with what for the sake of convenience may be called matrix. It is in part slate and in part massive hematite, and the two appear to the eye to grade into each other imperceptibly. The value of the bed has depended upon the portion of slate in this matrix, and the argillaceous character of the ore has been one of its weaknesses.

Tunnel lead analyses.—The set of analyses, similar to those quoted for East Branch and Iron brook, is not available here; for it is impossible, by the station mark labels, to identify the pits.

From the Nova Scotia Steel and Coal Company are obtained the following:—One sample labelled "Doctor brook," but said to be the Tunnel lead on the hill where the trenches are, gave A-65; the engineer of the company states that the workings of the lead averaged approximately A-66.

	No. 121	No. 122	No. 123	No. 124	A–65	A–66
Fe.	43.450	47.150	52.370	49.060	48.84	48.00
SiO_2.	24.600	18.190	13.640	16.130	18.60	....
Al_2O_3.	5.330	7.800	6.360	7.270	....	....
CaO.	3.900	1.650	1.300	1.600	....	....
MgO.	.120	.720	.460	.280	....	....
P.	1.230	.720	.486	.585	....	....
S.	.004	.003	.013	.003	....	....

Coarse lead.—The Coarse lead, first met at Iron brook, is exposed in pit No. 19, on Louis Macdonald's farm. This gives a distance of 975 feet from Iron brook in which there are no openings. In this pit the foot-wall was not exposed. Southward the section gave:—

Ore.	7′–0″	
Ferruginous quartzite.	1′–0″	
Ore.	3′–0″	total 11′–0″

North wall of quartzite.

The strike and dip are N. 65° E., 83° N.W. The ore is extremely coarse and siliceous, with many granules of white and smoky quartz.

Sample 93 is a general section of the belt, excluding the rock; No. 126 is selected from a large dump.

	No. 93	No. 126
Fe.	22.32	35.31

The next opening is pit 46, on Andrew Macdonald's property. In this there are no walls visible, the ore running into the gravel on both sides. Ore shows for a breadth of 11 feet, without any rock parting. It is extremely siliceous and full of quartz grains in the middle, but better at the sides. Sample 119 is a general section of the floor of the pit.

	No. 119
Fe	38.82

The westernmost pit on this lead before the valley of McInnes brook is reached is No. 49, on John McDonald's farm, beside a mountain trail. This shows the tuff-agglomerate on the south wall as in Iron brook. The ore is coarse but not so pebbly as in pit No. 46. It does not become more siliceous toward the tuff; but it replaces the latter for a few inches irregularly, showing the secondary origin of the iron. The bed strikes N. 82° E., and dips 70° S.

In the present condition of the pit only upper edges are visible, and these are mainly constituted of rock matter which forms a capping. This rock only represents a surface impoverishment of an iron-bearing belt, which, at a shallow depth, develops into a full width iron ore body. These conditions are often encountered in the Arisaig district.

At the bottom the ore is said to be 7 feet wide. Sample 117 came from the bottom of the pit and is a general test of a two or three ton dump.

	No. 117
Fe	39.61

Pit No. 50 is a small one, opened as the inspection of the district was being completed, and it is thought by the owners to be on the Coarse lead. It is out of range, and its ore is different, being coarsely oölitic. When visited, only 4 feet of ore could be seen, and no walls. No sample could be taken.

Intermediate ore bed.—Between the Coarse and the Tunnel leads, on the high land between Iron and McInnes brooks, is a bed apparently of moderately good character. One of the pits on Iron brook (No. 7) is upon this lead. On the mountain the easternmost exposure is pit No. 20, on the property of Louis McDonald, and north of pit No. 19. The south wall is quartzite, blending into ore. The section northward is:—

Quartzite grading into ore	1′-0″	
Ore	0′-8″	
Ferruginous quartzite	1′-0″	
Good ore	2′-0″	total 4′-8″
North wall decayed slate		

The ore is very fine grained. The belt strikes N. 83° E. and dips 77° N. Sample 92 is a general one of the ore portions of the belt; 125 is selected from a dump.

	No. 92	No. 125
Fe	40.93	43.62

From the north wall of No. 19 to the south wall of No. 20 is 46 feet; from the former point to the centre of the Tunnel lead the distance is 100 feet.

South of pit No. 44 on the Tunnel lead, No. 45 may perhaps have been on this Intermediate lead. As it has now fallen into decay nothing could be ascertained, except that it contained fine grained ore of fair quality, with some shells. Sample 120 was selected from the dump.

	No. 120
Fe	53.270
SiO_2	12.000
Al_2O_3	7.260
CaO	2.000
MgO	.320
P	.840
S	.013

Pit No. 48 is one of the western line of openings beside the trail, on the edge of McInnes brook valley. It is thought by those who have worked on the property to be on this lead, but the resemblance is not close. It is also regarded by them as identical with the middle ore bed on the west side of McInnes brook, to be described presently; and the resemblance is better in this case. Too little ore had been opened to permit sampling. It is all unusually siliceous, rock and ore mixed across a belt approximately 12 feet broad. The north wall is light gray quartzite, the south wall a black ferruginous quartzite, striking N. 88° E. and dipping nearly vertical, about 88° S.

Miscellaneous pits.—N. 6° W. 75 feet from pit No. 48 is No. 47. This gives, from north to south:—

Ore	1′- 8″	
Quartzite	1′- 4″	
Ore	0′-10″	total 3′-10″
Quartzite wall		

The wall strikes N. 86° E. and dips 85° N. to vertical. Sample 118 is taken across the face, excluding the parting.

	No. 118
Fe	45.000
SiO_2	28.400
Al_2O_3	.840
CaO	1.050
MgO	.420
P	.530
S	.015

This lead should be approximately in the position for the Tunnel; but by its section and its ore it is not, nor is the Tunnel lead found again east of the west bank of McInnes brook.

Pit 18 is an isolated opening east of the easternmost cut on the Tunnel lead, on John McIsaac's property. It is north of the range of the Tunnel lead and its ore is fine-grained and even. Sample 132 is a general one of a very small dump.

	No. 132
Fe..	41.40

McInnes brook.—Several pits have been opened on the west branch of this brook, most of them at some distance above the bed of the stream and clustered about the base line. They are all on the property of John McInnes. Chief of these is the Tunnel opening (No. 40), on which the Nova Scotia Steel and Coal Company began to work. This is a short level driven into the hillside. It is noticeable that, although the ground eastward to the beginning of the main Tunnel lead openings appears to be faulted, this western pit is almost directly on the base line along which the belt strikes toward Iron brook.

The ore here is of the characteristic kidney variety. The walls are peculiarly notched with left-handed offsets, as shown in the accompanying sketch. The width of the belt varies from 4 feet 10 inches to 5 feet 8 inches according to place. On account of this notching the strike is difficult to get with accuracy. The dip is 83° N. The ore was supposed to have disappeared against a small fault; but was found again in the course of investigation of the district in 1906, coming in on the bottom of the tunnel at its eastern end. Samples 115 and 140 are general tests of this re-discovered ore.

	No. 115	No. 140
Fe..	40.87	43.68

South-west from this pit and above it is No. 38. This exposes a bed of 8 feet of ore, striking N. 85° E. and standing nearly vertical. Both walls are hard quartzite and the contacts are irregular. The ore is fine and siliceous, and shows some pyrite, which is unusual in this district. This is probably the Intermediate ore bed. Sample 112 is a general one across the opening.

	No. 112
Fe..	41.10

South-west of No. 38 is a trench 20 feet long, now fallen in (No. 43). From those who opened it it is learned that three feet of the south end contained iron.

(*a*) Pit No. 40, looking west.

(*b*) Pit No. 29, looking east.

On the surface is a considerable amount of ore, from two dumps of which samples 113 and 114 were selected, the best being taken. The ore is coarse and oölitic, with visible quartz grains and a few shells. From its position and character it is judged to be the Coarse lead.

	No. 113	No. 114
Fe.	33.52	34.51

South-east from the mouth or east end of the tunnel of No. 40 are two openings on the hillside, so close together as to be practically one. Of these, one has so little and so irregular ore that sampling could not be done; the other, No. 41, was sampled (116).

	No. 116
Fe.	28.71

In the ravine east of pit No. 41, almost in the bed of the brook, an opening was made upon some irregular fine and siliceous ore (No. 42). Not enough had been shown at the time of inspection to permit sampling.

Chemistry of McInnes brook ores.—Certain of the threefold series of analyses already referred to in this chapter can be traced approximately to pits on and east of this brook.

Pit No. 47 is represented by the following:—

	Fe.	SiO_2	P	S
A–23 Hoffman	53.88	16.19	....	....
A–24 Pinkerton	50.90	17.00	.345	trace
A–25 Chambers	54.30	....	....	....

Pit No. 42, although new, is cut from a natural exposure, which is the probable source for drift ore giving:—

	Fe.	SiO_2	P	S
A–26 Hoffman	57.86	7.87	....	....
A–27 Pinkerton	50.43	15.20	.492	trace
A–28 Chambers	53.77	....	....	....

Somewhere between pits 38 and 41 two samples were taken, labelled alike:—

		Fe.	SiO_2	P	S
A–29	Hoffman	43.63	28.88	....	....
A–30	"	44.25	26.75	....	....
A–31	Pinkerton	43.63	26.60	.255	trace
A–32	"	48.48	14.90	.744	"
A–33	Chambers	42.78	....	....	....
A–34	"	52.99	....	....	....

Averages of five analyses, by the three authorities quoted, taken on both sides of McInnes brook, are given below:—

		Fe.	SiO_2	P	S
A–35	Hoffman (numerical average)	47.86	22.37	....	....
A–36	Hoffman (re-analysis)	48.77	22.56	.42	none
A–37	Pinkerton	46.69	21.74	.418	trace
A–38	Chambers	48.41	....	....	....

These are all the analyses referring especially to this part of the field, which are at present available.

Gillis brook openings.—On the farm of Wm. Gillis are two small exposures beside a brook. On the north-east a cut in the bank (pit No. 23) shows 12 to 14 inches of coarse oölitic hematite, with irregular walls. Sample 84 is a general section of the band. The ore is shown again on the south-west side of the brook, almost in its bed (pit No. 24). It is here very small and irregular, the walls exhibiting no evidence of permanence; and the two openings give no encouragement in this regard, unless upon further exploration the character of the bed improves.

This indefiniteness is characteristic of the iron ore as a whole. Sample 85 is a general test of such ore as could be seen.

	No. 84	No. 85
Fe	42.32	46.520
SiO_2	....	14.680
Al_2O_3	....	6.230
CaO	....	4.900
MgO	....	1.120
P	....	.785
S	....	.011

Western pits—West of the Gillis farm several pits have been recently opened, in part showing a continuation of iron ore beds known to the eastward.

On the Daniel McDonald property is pit No. 25, an opening on what is locally called the Black lead. The ore is black in colour, very feebly magnetic, and 10 feet wide. It is all siliceous, slightly less toward the centre. An irregular portion near the foot-wall is a mixture of incompletely oölitic hematite and magnetite. The strike is N. 68° W., dip 79° N.W. The hanging wall is a somewhat decayed light gray rock, either an impure limestone or a calcareous slate. The foot-wall is a massive quartzite; the ore between broken into rectangular blocks by three sets of joint planes, one parallel to the bedding, a cross set perpendicular, and another horizontal. An analysis made at Londonderry gave:---

	A-67
Fe	36.45
Insol	34.68

On the next property west are two pits, Nos. 26 and 27. The former is on a lead whose north and south walls had not been cut, being heavily covered with drift. The following section is visible:—

Drift (north side)		
Ore	5′-0″	
Rock Parting	2′-0″	
Poor Ore	2′-0″	total exposed 9′-0″
Drift		

The lower bed strikes N. 85° W., and is vertical The ore is coarsely oölitic, with a few shells. A considerable amount of rounded quartz is visible. Sample 108 is a general section across the exposed parts of the north bed; 110 is from a drift boulder a few yards south of this opening, the ore being similar in all ways to the Coarse lead.

	No. 108	No. 110
Fe	47.580	40.23
SiO_2	17.500	....
Al_2O_3	6.730	....
CaO	2.200	....
MgO	.560	....
P	.725	....
S	.007	....

Pit No. 27, on the same property, is on a westward extension of the Tunnel lead. The ore is in every way similar, but of poor quality, and mixed with slate. On the south is a greasy light gray slate, similar to that on the walls of the Leckie vein at Torbrook. Next is 14 inches of good kidney ore, from which sample 83 is taken. This is succeeded by 32 inches of extremely siliceous black to gray massive ore, grading out from the kidney ore quickly;

and finally the north wall of quartzite. The contacts are irregular, but the general direction is N. 68° W., dip vertical to 86° N. The walls have sharp turns with left-handed offsets. It is evident that the lead was uncovered in an unfortunate place, being on one of the knuckles or turns which have been shown to be characteristic farther eastward. There is good reason to expect it to straighten and widen, both east and west.

	No. 83
Fe	48.500
SiO_2	16.130
Al_2O_3	8.500
CaO	1.800
MgO	.500
P	.815
S	.047

On John McPherson's farm, the next to the west, are two pits. On the south is No. 28, on fine oôlitic ore, clean and even and with no highly siliceous portion. It is probably the Intermediate bed. Both walls are gray quartzite, the south one broken, the north massive. The ore breaks into rather regular rhombs. The strike is N. 62° W., dip irregular but about 75° N.E. Sample 111 is a general one across the lead.

	No. 111
Fe	34.85

North of this pit is No. 29, in fine globular ore, similar to that of the Tunnel lead. The lead strikes N. 60° W., and is vertical to 88° S.W. The section is:—

South wall, altered gray slate.		
Good ore	4′-0″	
Highly siliceous ore	2′-4″	total 6′-4″
Dense gray quartzite		

Two samples were taken. No. 81 is a general one of 4 feet of good ore; 82 is a general one of the siliceous portion of the bed.

	No. 81	No. 82
Fe	51.800	9.20
SiO_2	15.060	....
Al_2O_3	5.530	....
CaO	1.650	....
MgO	.620	....
P	.705	....
S	.007	....

A few other pits have been opened in this vicinity since the completion of the field work, for which some claim is made by the owners.

General Chemistry of the Arisaig Ores.

Unidentified analyses.—A number of analyses are available, singly or in groups, some of which can be identified as far as the section to which they belong, some not at all.

(1) From the Londonderry Iron and Mining Company's laboratory come the following:—No. 1 is east of the road at East Branch, and is probably No. 1 pit; No. 6 is the large quarry west of the brook, pit No. 13 of the present study; No. 2 is spoken of as opened in several places, so may be the series of three west of the brook, Nos. 5, 10, and 14. What the Tunnel vein is, is not known, as the present survey did not recognize it east of Iron brook.

		Fe	Insol.
A–39	East of road	45.890	26.010
A–40	No. 6, 20 feet ore and stone	43.160	29.230
A–41	No. 2, about 12 feet	34.350	42.640
A–42	Tunnel vein	45.740	24.820
A–43	Average of East Branch	42.535	30.625

On Iron brook:—

		Fe	Insol.
A–44	No. 1, said to be 16 feet	35.130	39.04
A–45	No. 2, " " 10 feet to 12 feet	39.000	34.55
A–46	No. 3, " " 10 feet	40.870	29.67
A–47	No. 4, " " 10 feet }	32.980	43.06
A–48	No. 5, " " 5′–6″ }		
A–49	No. A, between 5 and 4, small	35.850	43.07
A–50	Average for Iron brook	36.768	37.88

(2) From the Nova Scotia Steel and Coal Company's laboratory come several, represented as being from the best places, and carefully culled samples, but with no labels. One series, A–51 to 60, gives Fe 42.90, 45, 37, 46, 41, 49, 46, 44, 41, 51. Two others:—

	Fe	SiO_2	CaO	P
A–62	43.00	14.40	7.50	.50
A–63	34.00	19.40	2.90	....

(3) From Londonderry; sample marked "Williams," locality unknown.

	Fe	SiO_2	Vol. matter
A–64	53.41	10.20	2.2

Chemical quality.—In the various analyses quoted, certain facts are made evident. The ore is uniformly free from sulphur, but, as is to be expected in a Clinton ore, it is high in phosphorus. Silica and general insoluble matter stand unfortunately high, the average of all Mines Branch analyses being 20.884, and of all the others obtainable at present, 28.655. In iron the general quality is low, the average of Mines Branch analyses being 38.186, that of all others obtainable, 42.514. It must be noted that the Mines Branch samples show only the best ore, especially as regards silica; hence the figures are too optimistic.

Such averages, although likely to mislead, have their value; thus they show that the district, as a whole, is characterized by low iron and almost disastrously high silica.

But it may well be that of the veins present some are persistently too poor to work, and others, on the average at least, passable. Thus, averages of all Mines Branch analyses of what can lay fair claim to being the Coarse lead give as follows:—

	A–68
Fe	35.167

In like manner, averages from all sources of the Tunnel lead, (A–69) on the hill west of Iron brook, (A–70) McInnes brook and westward, and (A–71) a general average, give:—

	A–69	A–70	A–71
Fe	48.174	46.213	47.302
Insol.	18.232	15.595	17.479
Al_2O_3	....	....	6.802
CaO	....	....	1.333
MgO	....	....	.450
P	....	....	1.485
S	....	....	.013

The Intermediate ore bed, between the Tunnel and the Coarse leads, as far as can be identified, gives for the three divisions just mentioned:—

	A–72	A–73	A–74
Fe	45.94	41.177	43.558
SiO_2	12.00	17.500	14.750
Al_2O_3	....	....	7.175
CaO	....	....	2.100
MgO	....	....	.440
P	....	....	.783
S	....	....	.010

These would seem to indicate (1) that the iron content increases materially, but not evenly, westward; (2) that the silica is ruinously high at the eastern part of the district, becoming less so westward, but usually high; (3) that the Coarse lead is not of marketable quality so far as now known; (4) that the Tunnel and the Intermediate leads may be economically valuable under favourable conditions.

Physical Problems

Continuity along strike.—It has already been remarked that none of the iron ore beds on East Branch or eastward can be identified with certainty as occurring on Iron brook or westward. The means of possible identification are two—similarity of ore and wall rock, and identity of relationship to some known rock horizon. Both these criteria can be used here to some extent, but neither alone nor both together will be found adequate for the whole district.

Taking the second first, on the hill between Iron and McInnes brooks a red slate appears some distance to the south of the Coarse lead at the west end, opposite pit No. 49 and south of the volcanic tuff beds. Eastward this can be traced to Iron brook, there, however, having diverged from the Coarse lead. It was found in thick woods and its exact distance from the lead was difficult to determine. At East Branch, on the east side, a red slate in every way similar is exposed on the valley side some yards north of the base line. Whether it is the same slate, and whether iron ore beds to the north of it at the last place are the same as in nearly similar situations farther west, cannot be decided definitely. The slate can be traced east intermittently for some distance towards the McKenzie veins.

Westward from the hill above mentioned it is found in the woods south of the McInnes brook openings, but again at a greater distance from the Coarse lead than on the hill east of the brook. It is said to have been traced as far west as the McPherson property or beyond, but was not seen. From its distribution it is some aid to identifying the zone carrying the ore beds, if only in a general way. It might be useful east or west of the present limits of the field to indicate roughly the situation of this zone.

A better guide in detail is the wall rock south of the Coarse lead, the volcanic detritus permitting recognition of it before enough of the ore can be seen to make sure of its characteristics. Thus in the Iron brook district it is the first clue to faulting. This is the only wall rock available over any considerable distance. Where an ore belt has one wall of quartzite and the other of slate it may be possible to distinguish folding from repetition in any restricted section; for folding would of necessity give the beds in reverse order, in crossing from one side of the fold to the other. So far this criterion has not been used in the Arisaig district.

The greatest distance over which any single ore bed has been found is 6,750 feet, the Tunnel lead from the east side of Iron brook to the McPherson property covering that length. The Coarse lead is probably continuous for at least as great a distance, although not opened so far west. This is a very considerable length for one iron ore bed to be practically uninterrupted, and although it is not workable in all parts, a sufficient proportion of the Tunnel lead gives promise of good body and quality to make it a prospectively valuable deposit.

There is at present no means of knowing where the break comes between Iron brook and East Branch, nor how great the offset; nor even whether any of the deposits in the two sections are the same.

As to the beds on East Branch, it is difficult to make sure of the identity of any on the two sides, because of the evidence of folding on the west bank. That in certain cases the deposits are continuous across the valley is quite probable, but uncertain. Eastward towards the McKenzie leads knobs of trap protrude through the strata in great profusion. It would be impossible, without very detailed prospecting, to tell how far the ore at either end is continuous toward the other. To the eastward from the openings on McKenzie's farm the strata are moderately free from intrusions for a mile, to the foot of Sugarloaf mountain. But to the north and north-east, and within 250 yards at the nearest point, is a contact between the Ordovician and a large mass of trap, which extends thence north to the coast and east for two miles, and in which the small blebby deposits of Grant brook are found. From their present strike it is probable that the McKenzie leads, if continuous, run against this contact within about 1,200 or 1,500 feet of the openings.

Extension of field.—On the east, the point mentioned above as the probable terminus of the McKenzie leads marks the utmost limit of the ore field in that direction. The deposit on Ronald McDonald's farm, south-east of Sugarloaf and east of the trap contact, is isolated and unlikely to be continuous in either direction for a great distance.

Westward it would at first seem that the field should reach out for a great distance; but account must be taken of the change in strike of the ore beds and the accompanying strata. While in the east they average north-east, west of McInnes brook they curve rapidly toward the west and north, converging upon the contact between the Ordovician and Silurian to the north-west. Hence, within a short distance, the iron on the McPherson property must, if continuous so far westward, stop at this contact. Without working out in great detail the geology of the district, it is still possible to say that these deposits may extend 1,200 feet westward of the pits now opened on the McPherson property, but probably no farther, unless they take an unexpected turn southward, or are offset in that direction by faulting. Even within these limits the main ore field of the Arisaig district is an extensive one.

In breadth the main field has no great extent; but as the ore beds are nearly perpendicular at the surface, it may be possible to extract a large amount of ore within a moderate width of productive territory. Reports are abundant of iron to the south of the lines of present openings, but cannot be verified up to date of writing. The iron ore occurrence on Gillis brook is isolated; in close proximity to a trap intrusion which may interfere with its continuity on one side, and on the other to the Silurian contact, toward which its strike carries it. Being as it is far north of the main iron-bearing range, it may be neglected in an economic consideration of the district.

The Silurian iron ore, on Ross and Arisaig brooks, is of a type that should persist for a considerable distance; and if it does, its topography would allow a large amount of ore to be extracted cheaply, although the walls are unusually soft and insecure. But the glacial drift is in places heavy along the line of strike of the beds, and no prospecting appears to have been done.

Continuity in depth.—Of equal importance with the longitudinal extent of the field is the character of dip of the ore beds and the continuity of the latter in depth.

On the first point little need be said. As has been seen, there is some evidence of close folding at East Branch. How wide-spread this is is not known; but at present no evidence of it exists to the westward. All the dips in this part of the Ordovician are high, chiefly north and north-west; and it is very probable that in depth the beds will continue to have high dips as far down as they may be worked. At all events, there is no evidence of blanketing. In the Silurian also the dips are uniformly high.

The problem of downward extent of the iron ore itself is, however, a serious one. No underground work has ever been done to solve it; and it is much to be regretted that it was impossible to secure a core drill for use during the recent investigation, as thereby much could have been learned at a minimum cost, and the value of the district perhaps greatly enhanced.

As it is, two lines of testimony are available—(1) the present topography of the ore zone and its relation to the condition of the iron; (2) the nature of the deposits as a whole.

(1) The topography of the country is quite varied, along the line of the iron as well as from the coast inland. This is due to the presence of the branches of Doctor brook, which, while small, have nevertheless cut for themselves deep ravines.

The lowest point is reached in East Branch, where the line of the iron zone is cut by the brook bed at an elevation of 228 feet. The lowest outcrops are but a few feet above this, and the ore may safely be assumed to continue at least as low as the brook level in this valley. The highest point between this and Iron brook is 450 feet, a rise of 222 feet. Iron brook is 424 feet elevation. As iron has not yet been proved to extend between these brooks, the altitudes cannot be of use except indirectly.

From Iron brook westward, however, the individual beds can be traced. The highest point before McInnes brook is reached is 482 feet. The east branch of McInnes brook is 400 feet elevation. West of this the highest point recorded is 520 feet. As the iron ore beds swing westward and northward, their outcrops no longer keep on the highest land, but decline somewhat toward the valley of Doctor brook.

(2) The ore bodies of this part of Arisaig are broadly of the bedded type, although departing from the rock stratification in a few places, sometimes through irregular replacement, sometimes proceeding for a very short distance

along fissures. These bedded ores, widely distributed in rocks of Ordovician and Silurian age in the Appalachian division of the United States, are characterized normally by great persistency in strike and depth. They are regarded by many students as replacements of rock strata. It has already been explained (Part I, chapter 3) that most iron ore is a secondary deposit formed by descending water, and therefore is comparatively shallow. But the Clinton ores are found to a depth of many hundred feet, in some instances, frequently, but not always, with a decreasing content of iron.

While the greatest difference in level on one ore bed is 120 feet, between the east branch of McInnes brook and the high land to the west, nevertheless the iron is in every essential similar throughout. Ores of this type are never, so far as known, formed during continuance of the present topography, but precede it in age, although often in a very general way dependent upon it.

In the main Arisaig deposits there is no difference that can be ascribed to topography, between the highest and lowest exposures of the beds; and the conclusion seems justifiable that the ore beds should hold their iron ratio for a considerable distance below the level of Doctor brook, and probably at least to the sea level.

Mention has been made earlier of the trap intrusions. Just how troublesome they may be can only be discovered in the course of exploration. They may seriously interfere with the continuity of the ore in depth, especially about East Branch.

Amount of ore.—It is inadvisable to attempt any estimate of the total amount of ore, at least east of Iron brook, without far more knowledge of the deposits than is at hand.

In the case of the three identified beds from Iron brook west, the best estimate of thickness that can be made, from the various openings of ore that may be presumed to be workable, gives:—Tunnel lead 5 feet, Intermediate lead 4 feet, Coarse lead 10 feet. It is probable that the last must be thrown out of account, as being everywhere too siliceous to pay. With it there are 19 feet, without it 9 feet of workable ore.

Estimates for Iron brook, East Branch and McKenzie brook are of little value. In the first two cases there is some duplication of beds, and in all the ore is high in silica. All the estimates of thickness and tonnage of workable ore for this district seen by the author appear to him to be far too high.

Working policy.—These ore beds are better situated for inexpensive working than almost any other deposit in the province. In the first place, they are standing at a high dip so that little weight falls upon the walls, and the latter are uniformly hard and firm; thus little timbering would be required. In the second place, the topography is such that a large amount of ore could be taken out by gravity, with natural drainage, and requiring no hoisting. As hoisting and pumping are the two greatest items of current expense in many mines, and shaft sinking is the heaviest initial expense, the conditions at Arisaig will be seen to be extremely favorable in these respects.

For the western ores, the best way to develop would be by an adit level, from the valley of Doctor brook on the McPherson property. That would open the beds at the lowest point possible without an adit of too great length. The probable distance to be cut before striking the Tunnel lead is approximately 600 feet, to give a height of ore overhead of 200 feet.

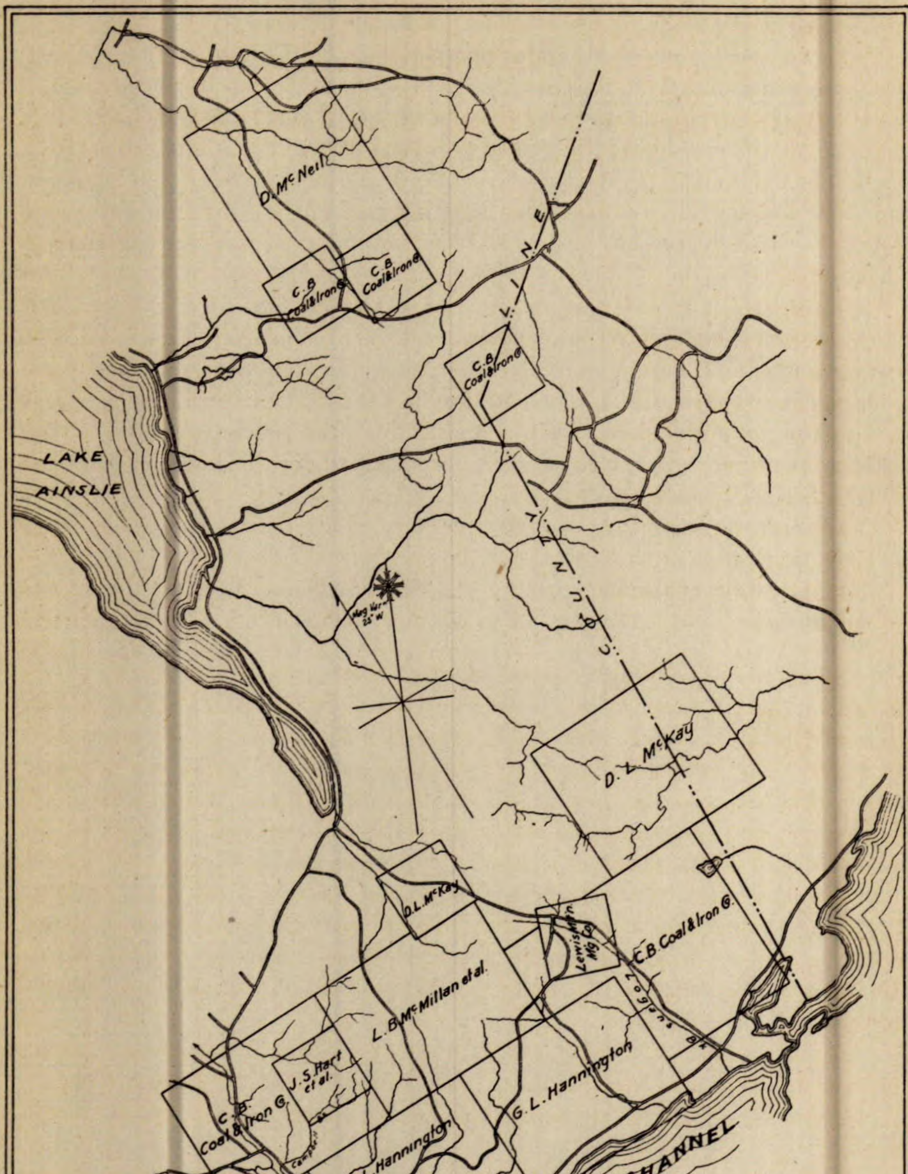
All the district needs a careful prospecting by drill holes and small test pits, before any undertaking is set on foot looking to large scale development. Especially is this true at the east. None of the East Branch beds have been proved for any considerable distance; and the proximity of numerous small trap knobs makes it imperative that the depth of the iron ore should be ascertained by a core drill and its quality sampled to see if its silica decreases and its iron increases before any value is placed upon the leases for commercial purposes.

But drilling is required as well west of this brook. Some of the territory is evidently faulted, and the characteristics of the broken ground are unknown. If several flat breaks are present, such as the Nova Scotia Steel and Coal Company met in working the Tunnel lead, the fact should be known. It is necessary to prove the depth of the iron ore in unfaulted portions as well. Few fields in the province would give more information under the search of diamond drills than this.

In surface prospecting, it must not be overlooked that the glacial drift has here gone north or shoreward, for the most part.

The question of local smelting is not discussed here, because there is as yet no evidence that enough good grade ore could be found to warrant it.

PLATE 57.


D. McNeil
C.B Coal & Iron Co
C.B Coal & Iron Co
C.B Coal & Iron Co
LAKE AINSLIE
COUNTY LINE
D.L. McKay
D.L. McKay
Lewis Mg Co
C.B Coal & Iron Co.
L.B. McMillan et al.
J.S. Hart et al.
C.B. Coal & Iron Co.
G.L. Hannington
G.L. Hannington
R. Drummond
P.P. Fraser et al.
WHYCOCOMAGH
INDIAN ISLAND
ST PATRICK CHANNEL
INDEX LEASE MAP
WHYCOCOMAGH IRON DISTRICT.
CAPE BRETON.
Scale of Miles.

CHAPTER 7.

IRON ORES OF WHYCOCOMAGH AND MIDDLE RIVER, CAPE BRETON.

CONTENTS OF CHAPTER 7.

Situation.—The Whycocomagh district is situated in the centre of the island of Cape Breton, at and near the head of St. Patrick channel, a long arm of Great Bras d'Or lake which reaches westward from the main sheet of water. The Bras d'Or lakes are a series of connected bodies of salt water, which debouch into the open ocean on the east through two mouths north of Sydney, and are connected artificially with the ocean on the west at the southern end of the strait of Canso. They have practically no rise of tide.

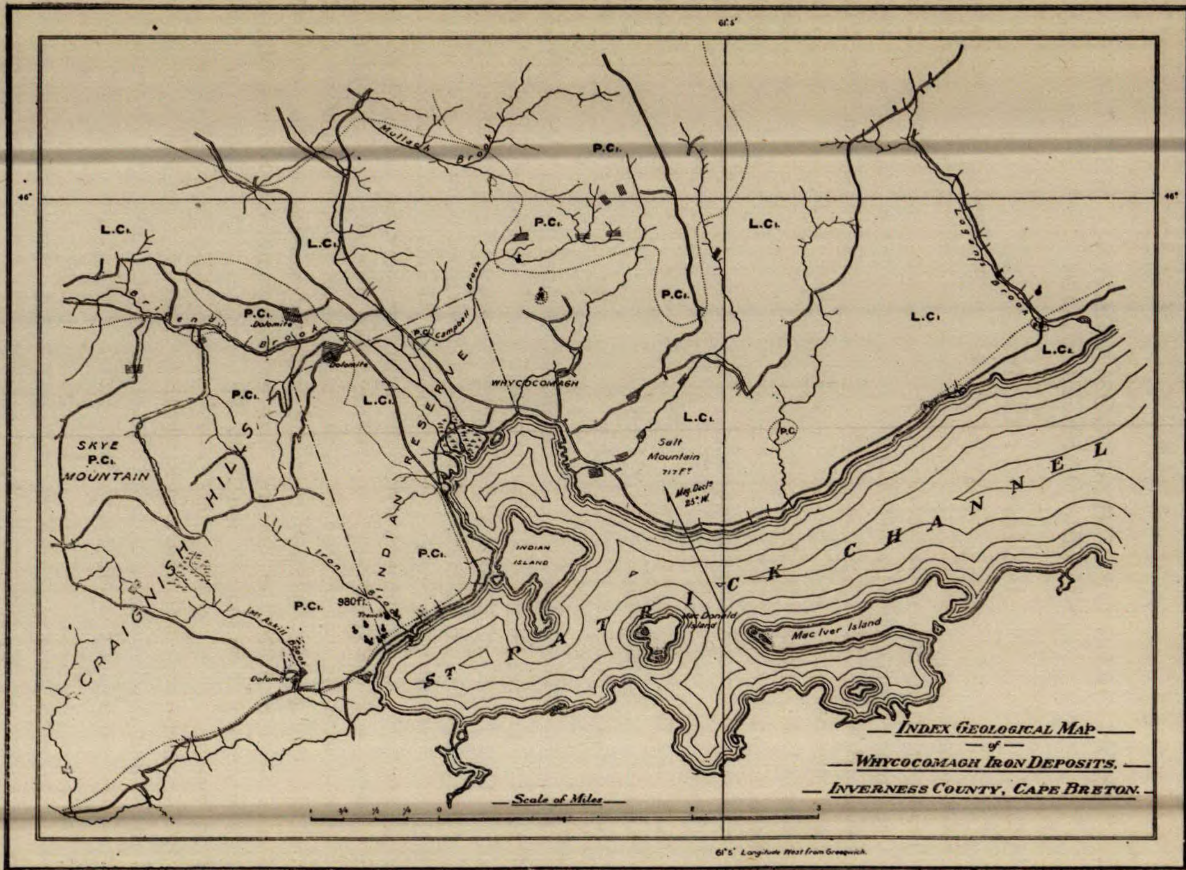
Transportation, power, timber.—The village itself is eight miles by road from the Orangedale station of the Intercolonial railway, which is about 65 miles distant from the smelting centres of Sydney and Sydney Mines. Water transportation can be had from Whycocomagh during seven months of the year.

Brigend brook, at the head of St. Patrick channel, is capable by storage of furnishing good power. None of the other brooks have enough water.

The mountains contain much hard wood, chiefly small, and some soft wood.

Occurrences north of Whycocomagh.—North of Whycocomagh village are the hills locally called the Mullach (Plate 58). They are composed, in their central part, of pre-Cambrian rocks, largely magnesian limestones and quartzites near the southern margin. Between the main part of the hills and the lake on the south are younger rocks. In the midst of these and a mile north of the shore is a small area of pre-Cambrian, not represented on

PLATE 58.


INDEX GEOLOGICAL MAP
of
WHYCOCOMAGH IRON DEPOSITS.
INVERNESS COUNTY, CAPE BRETON.
Scale of Miles
61°5' Longitude West from Greenwich
46°
L.C1
P.C1
WHYCOCOMAGH
Salt Mountain 717 FT
Mag. Decl. 25° W.
INDIAN ISLAND
Mac Iver Island
SKYE P.C1 MOUNTAIN
CRAIGNISH HILLS
INDIAN RESERVE
ST PATRICK CHANNEL
Mullach Brook
Logans Brook
Iron Brook
Campbell Brook
Dolomite
980 ft.

earlier geological maps of the region. Trailing down hill from this small exposure is drift of magnesian limestone with grains of magnetite in abundance. A north-south cut into the rock shows the same ingredients, the iron minerals nowhere in sufficient amount to be called an ore. Mixed with the lime and iron is a considerable proportion of tremolite (lime-magnesium silicate) and some hornblende (lime-magnesium-iron silicate). These will be mentioned again in describing the next locality.

There is nothing whatever in this opening to warrant expectation of economic values, but it has been regarded by the holders of the property as one of the assets of the latter.

On the south bank of Campbell brook pre-Cambrian limestones are irregularly impregnated with ferruginous silicate minerals, chiefly hornblende, which have here and there altered into magnetite. Although large dimensions have been claimed for the ore, a breadth of a few inches, and depth and length of a few feet, were the greatest limits seen in any one place. There is no true ore body, and at most not more than a few tons of ore of any grade could be won. Sample 142 was selected, the best ore from a small dump.

	No. 142
Fe	62.450
SiO_2	7.200
Al_2O_3	1.190
CaO	1.760
MgO	.580
P	.029
S	.289

Logan Glen.—Five miles east of Whycocomagh, beside Logan brook and a branch, specular hematite occupies irregular fissures in lower Carboniferous conglomerate. There is nothing to indicate permanence of the deposit, and all the evidence points rather to the absence of a workable body. Moreover, even picked specimens are not of high grade, so intimately are the country rock and ore mingled.

Sample 186 is a general test of 500 pounds of as clear ore as could be found. None of it exceeds 4 inches in thickness.

	No. 186
Fe	46.20
SiO_2	25.77
Al_2O_3	5.01
CaO	.55
MgO	.42
P	.10
S	.02

Lewis mountain.—A traverse was made north and north-west to Lake Ainslee, over Lewis mountain, covering several localities from which iron ore was reported. Everywhere the results of the search were the same, only stringers of specular ore being seen.

Summary of conclusions.—The various occurrences of this character noted in the district emphasize one point strongly. The country is one in which iron ore is widely distributed, but nowhere localized. Many fissures of irregular direction and of varying extent contain here a little, there a little, but there is no evidence to indicate that any of the surface iron will become better segregated downward into bodies of any economic importance.

Unfortunately those interested locally in the development of iron-bearing areas fail to recognize that all iron ore is not alike, and that indications that are favourable to large hidden bodies in one case are not at all favourable in others. All the high grade material seen in the Whycocomagh veins of specular ore means nothing whatever when considering the district from the economic standpoint. No event appears to have occurred in the history of vein-formation to bring enough iron minerals into one place to make a deposit of any value. Iron ore is so widespread on the earth, and its distribution by means of water circulation so easy, that some very definite influences must have been felt if it is found other than in a scattered form. Such influences seem to have been absent from the pre-Cambrian and lower Carboniferous north and east of Whycocomagh.

Skye mountain.—At the head of St. Patrick channel and south-west of Whycocomagh village, Skye mountain forms the east end of the Craignish hills. These are composed of pre-Cambrian igneous and sedimentary rocks. Iron ore has been reported from a number of widely separated localities in these hills, but of these only the openings on Skye mountain proved upon search to have any importance. There are on the slopes of this hill two tunnels, one of them partly in ore, and a number of shallow pits or surface scrapings. These are chiefly on what are known as the Drummond leases, and upon the Fraser lease.

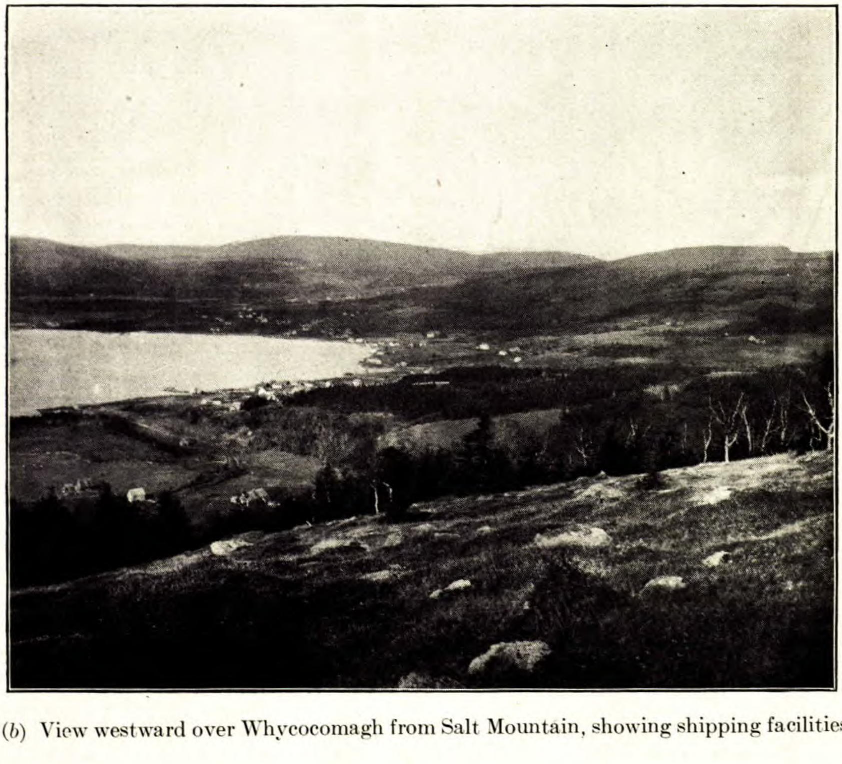
Iron brook: tunnels and exposures.—The first brook with permanent water, north of McAskill brook, has no name in local usage or on the maps. For the present purpose, at least, it may be called Iron brook. On its south bank, cut into the steep valley side, are three tunnels made in search of iron in 1897, and much scratching of the surface has been done for a considerable distance up and down-stream. (See Plate 60).

The ore body cut in the upper tunnel and shaft appears to be an irregular filling or impregnation rather than a lode, and its shape is by no means as regular as would be inferred from the sketch map.

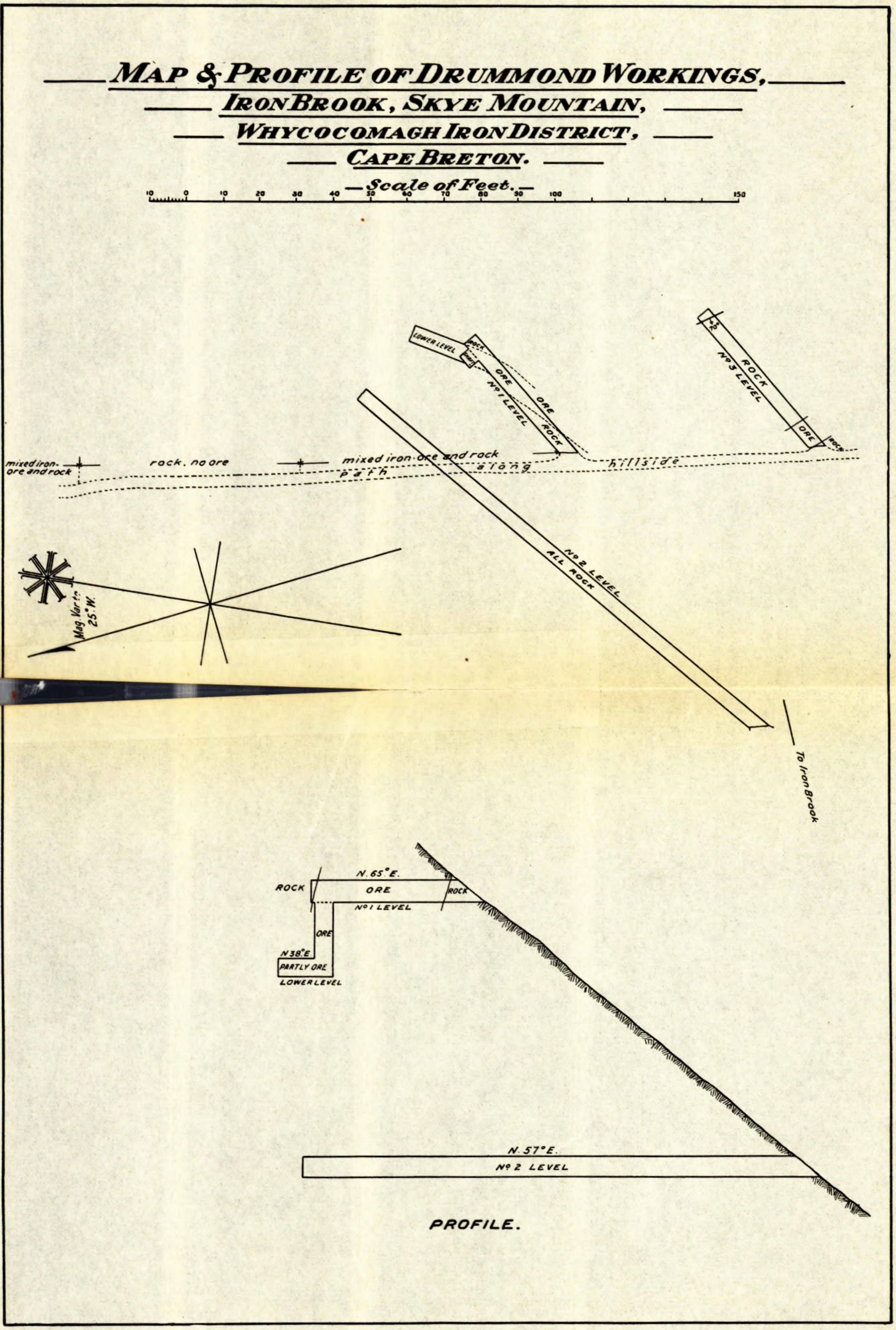
The ore is a magnetic hematite, often very fine and granular to compact, in some cases rather coarse. The hematite character is not uniform, as the streak or powder varies from black to brown, occasionally red. The wall rock is a dark gray quartzite, often impure. Angular tongues and horses of it are met in the ore. Where the quartzite is partially impregnated with

PLATE 59.

(*a*) Valley of Brigend brook and Indian river, looking west.



(*b*) View westward over Whycocomagh from Salt Mountain, showing shipping facilities.


MAP & PROFILE OF DRUMMOND WORKINGS,
IRON BROOK, SKYE MOUNTAIN,
WHYCOCOMAGH IRON DISTRICT,
CAPE BRETON.
Scale of Feet.
10 0 10 20 30 40 50 60 70 80 90 100 150
LOWER LEVEL
ROCK
ORE
No 1 LEVEL
ROCK
No 3 LEVEL
ROCK
ORE
mixed iron-ore and rock
rock, no ore
mixed iron-ore and rock
path along hillside
No 2 LEVEL
ALL ROCK
Mag. Var.n 25° W.
To Iron Brook
N. 65° E.
ROCK
ORE
ROCK
No 1 LEVEL
ORE
N 38° E.
PARTLY ORE
LOWER LEVEL
N. 57° E.
No 2 LEVEL
PROFILE.

iron ore the former is especially dense and hard. At and near the contact of the vein the country rock is often much fractured and contains large amounts of pyrite. This pyrite is found also in the iron ore, decreasing toward the centre.

In the lower tunnel no ore was cut, although the drift runs far beyond the point where a downward extension of the ore body, as it appears in the upper workings, would carry it. Rock heavily impregnated with iron may be seen on the hill side for 75 feet down-stream and 60 feet up-stream from the upper workings. The third tunnel is in a body somewhat similar to the other, but smaller and more irregular.

Sample 180 is a general sample of the surface of a hillside dump of about 150 tons, from the shaft in the upper tunnel. Number 181 is a general sample of the south-east side of the vein, at the back of the tunnel, taken from the wall where the ore is siliceous, to the middle. Number 183 is a picked sample from the centre of the vein, at the back of the tunnel. Number 184 is from the short tunnel up-stream; one-half taken from one foot on the foot-wall, where the ore is cleanest, and one-half from a dump of ore from the hanging wall. Sample 146 is picked from some boulders of ore on the dump in front of the lower tunnel.

	No. 146	No. 180	No. 181	No. 183	No. 184
Fe	57.050	53.400	47.400	56.600	56.70
SiO_2	11.160	12.920	23.700	9.000	15.04
Al_2O_3	5.200	4.410	3.400	7.960	3.52
CaO	1.800	2.050	1.350	1.950	1.60
MgO	1.660	1.600	1.740	1.680	1.70
P	.490	.770	.570	.805	.10
S	.006	.016	.128	.009	.02

Other occurrences.—There are several other occurrences on which more or less work has been done, but none of these are at present of economic importance. The deposits are limited, and generally very local in character, the ore, as a rule, being impure and mixed with a large proportion of sulphur (pyrite).

Early analyses.—Early analyses of Skye mountain ore from various sources are given below, in order that all available data may be at hand which may serve as an indication of the value of the district.

	Fe	SiO_2	Al_2O_3	CaO	MgO	MnO_2	P	S	TiO_2	Moist.
W- 1...	42.64	....	......	......	......	......	....	......	......	......
W- 2...	55.70	13.00	......	......	......	......	trace	.68	......	......
W- 3...	60.90	10.80	1.40	1.85	1.64	......	none	.11	......	......
W- 4...	57.20	14.80	......	......	2.75	.488	.44	none	......	......
W- 5...	60.00	6.00	......	......	2.40	.200	1.566	none	......	2.00
W- 6...	36.67	42.80	......	......	3.32	......	.661	none	......	......
W- 7...	46.16	24.34	5.52	3.12	......	......	trace	.51	trace	2.77
W- 8...	56.00	10.04	5.85	2.49	......	......	trace	.14	......	1.29
W- 9...	41.28	....	......	......	......	......	....	......	......	......
W-10...	50.10	13.53	......	......	......	......	....	.45	......	......
W-11...	53.40	14.21	......	......	......	......	.12	.28	......	......
W-12...	52.15	22.03	2.42	.80	......	.250	.41	.03	......	......
W-13...	38.50	39.50	......	......	......	......	.46	.04	......	......
W-14...	43.32	29.87	......	......	......	......	....	......	......	......
W-15...	51.50	17.44	......	......	......	......	....	......	......	......
W-16...	41.42	40.20	......	......	......	......	....	......	......	......
W-17...	51.77	16.27	......	......	......	......	....	......	......	......
W-18...	49.59	....	......	......	......	......	....	......	......	......
W-19...	42.51	....	......	......	......	......	....	......	......	......
W-20...	50.68	....	......	......	......	......	....	......	......	......
W-21...	42.51	....	......	......	......	......	....	......	......	......
W-22...	50.14	21.95	......	......	......	......	....	......	......	......

The exact location of these analyses is impossible to state; but it seems probable that as a whole their iron values are higher than any shipping tests would give, and that large quantities of ore of such quality are not to be expected.

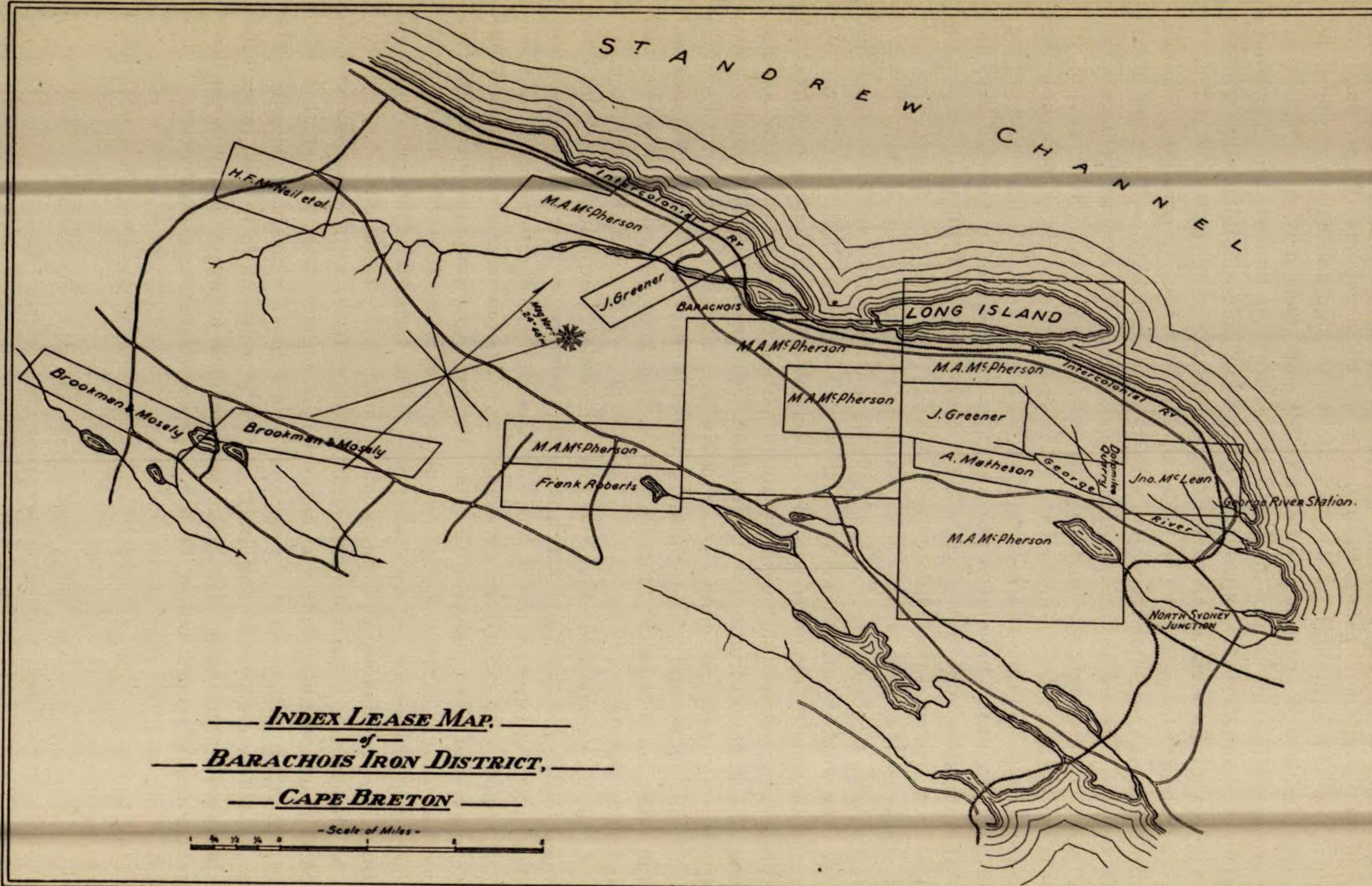
Summary of conclusions.—The descriptions given above indicate the conditions affecting permanence, which the iron ores of Skye mountain seem to exhibit. The openings on Iron brook, the only ones which are sufficient to give much indication, show certain peculiarities; and these are enhanced by the appearance of the iron ore in most of the other openings and exposures. It seems evident that the ore occupies irregular and erratic rock fractures, which on the whole are more likely to be local than general, and restricted in dimensions. The result is a series of isolated or semi-isolated pockets of ore, with much irregular impregnation of the country rock to an extent too small to give working bodies. The ore pockets may contain a few hundred, a few thousand, or many thousand tons; and nothing except careful development will indicate their shape or contents. Moreover, these detached units of ore are apparently not situated along any well-marked zone, but scattered somewhat erratically; and prospecting for new ore is therefore attended with uncertainty.

At the same time it must be said that, in the only instance in which development has been attempted, the work might well have been differently planned, with the chance that the same outlay would give more information. A method often employed in opening iron deposits, not only here but in many other parts of the Province, is to go into or down upon the ore wherever first exposed, without paying attention to the surface distribution. This is all very well, if all that is desired is a few thousand tons of ore; but it is to be taken for granted that the search for iron is usually with a view to developing a stable and permanent property. A few men may *know* that they have small pockets of iron and that their supply is limited; and they may plan accordingly; but experience shows that almost universally owners believe they have far more than ever appears after thorough exploration.

Iron ore bodies are, unlike some metallic deposits, comparatively shallow for the most part, and the chances that size and quality will become more favourable with depth are less than the reverse. It therefore behooves the explorer to ascertain the surface extent of the ore body before sinking, at least so far as to satisfy himself that it has a fair size. If, in the case under consideration, more surface stripping had been indulged in, for one thing an adit would not have been run partly in rock before the ore was reached. Again, a knowledge of surface, extent and direction from near the brook level, up for say three hundred feet, would have rendered unnecessary the fruitless rock tunnel below. The whole appearance of the deposit favours instability, although there is probably much more iron ore in it than has yet been worked out. In prospecting for and exploring iron ore, the cardinal principle should be kept constantly in mind that, unless there is some special reason, dependent upon the history of formation of the ore, why that mineral should be concentrated into a well-defined, large and continuous body, it will inevitably be found as a series of irregular, ill-defined and detached masses. Unless and until regularity and continuity have been well indicated, the safest rule is to follow the ore closely, even though to do so should entail irregular mining.

It seems, however, that the Skye mountain portion of the Whycocomagh district is one from which a moderate amount of ore very likely will be shipped to smelters in the future, if the market conditions are favourable and transportation facilities are improved. At present the road from Whycocomagh to the railroad is of such character as to prohibit heavy traffic, without undue expense. It is not thought that the prospects are good for discovery of iron ore on the eastern end of the Craignish hills, in such quantities in single bodies as to favour very large scale operations.

Middle river.—In the district of Middle river, at the eastern end of St. Patrick channel, some iron ores occur in a shear zone one foot in width, in which are minute veins of hematite; but in no case do these deposits seem to be of economic value, although persistent rumours have been circulated concerning their large size. The same remarks appear to apply to Gairloch mountain, where nothing more than a few small stringers were seen.


ST ANDREW CHANNEL
H.F. McNeil et al.
M.A. McPherson
Intercolonial Ry
J. Greener
BARACHOIS
LONG ISLAND
M.A. McPherson
M.A. McPherson
Intercolonial Ry
M.A. McPherson
J. Greener
Dolomite Quarry
A. Matheson
George
Jno. McLean
George River Station.
River
M.A. McPherson
Frank Roberts
Brookman & Mosely
Brookman & Mosely
NORTH SYDNEY JUNCTION
INDEX LEASE MAP.
of
BARACHOIS IRON DISTRICT,
CAPE BRETON
Scale of Miles

CHAPTER 8.

IRON ORES OF BARACHOIS, CAPE BRETON.

CONTENTS OF CHAPTER 8. PAGE

Location.—Barachois is situated on St. Andrew channel, in the Bras d'Or lakes, twenty-two miles from Sydney by the Intercolonial railway. All the iron openings are within a short haul of the track, although in the McPherson areas the down grade is steep. (Plate 61, 62).

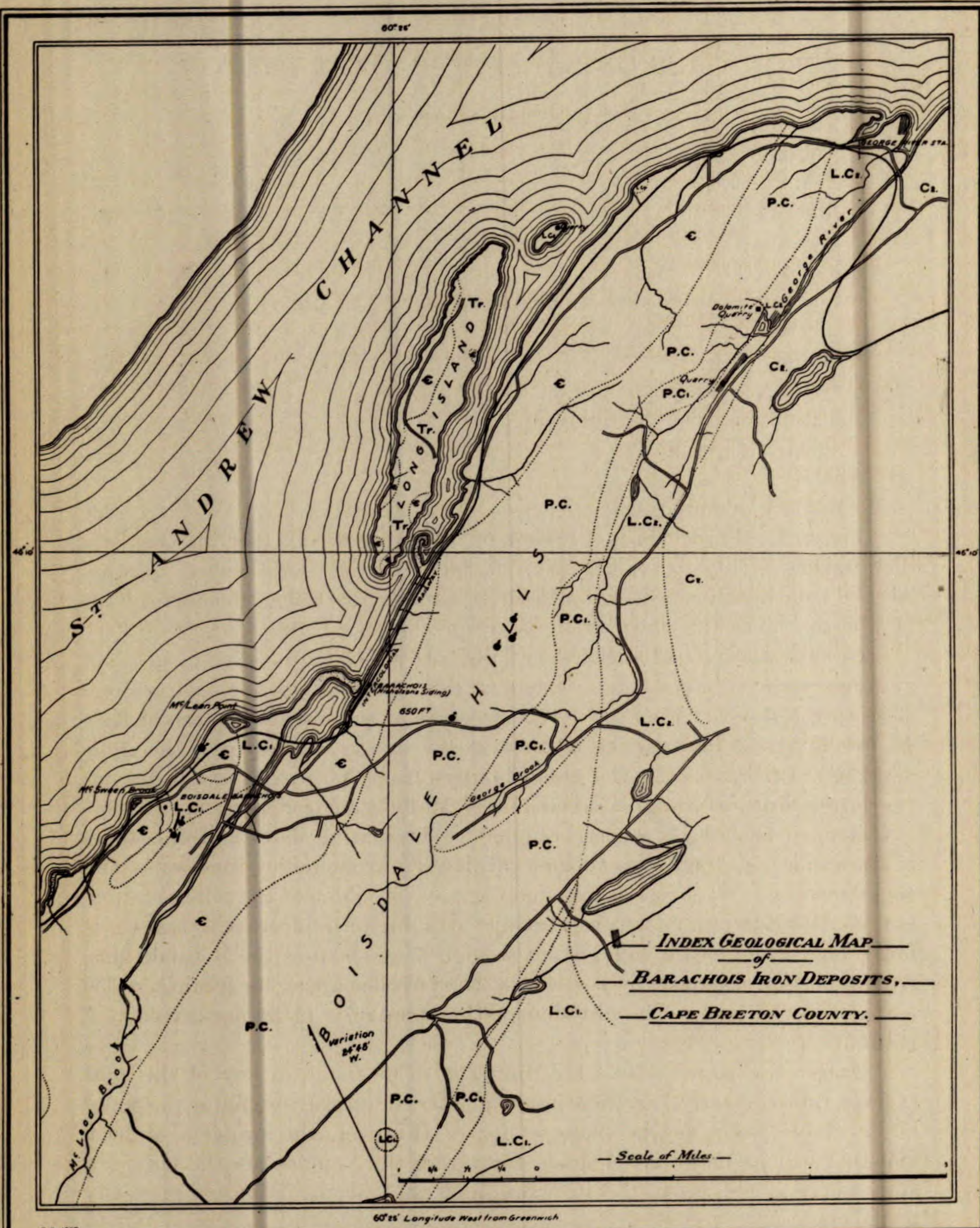
General geology.—The Boisdale hills, of pre-Cambrian sediments and granites, form a broad ridge, which at this point brings the high ground close to the shore of the lake. The direction of this ridge is approximately N. 30° E. (true), and to the south-west the divide recedes from the shore and the crest broadens. The upland ranges from 600 to 700 feet in height, the latter altitude being attained in the McPherson iron areas.

Nearer the shore is a zone occupied by alternating slates and limestones of Cambrian age, and a small area of lower Carboniferous limestones and conglomerates. This zone is extremely narrow at and near Barachois station, but south-westward it widens rapidly to a breadth of several miles. It forms land which, while hilly, is not so high or so steep as the Boisdale hills. At the portion occupied by the iron of the Greener areas, its summit is 350 feet above the lake. This division of the country is in large part easy of cultivation.

Timber and power.—No large timber is to be found in any of this part of Cape Breton county, but there is enough of medium size for mining purposes. Of available water power there is none. However, the problem of local smelting will probably never arise; for within thirty miles are the only two steel works at present in the Province, and rail transportation is practically at the ore.

Long island.—On Long island, off the Barachois shore, a very small pocket of red hematite and siderite occurs, but the amount is insignificant,

PLATE 62.



INDEX GEOLOGICAL MAP
of
BARACHOIS IRON DEPOSITS,
CAPE BRETON COUNTY.
ST. ANDREW CHANNEL
LONG ISLAND
BOISDALE HILLS
George River
George Brook
McLean Point
McSween Brook
McLeod Brook
BOISDALE
Dolomite Quarry
Quarry
650 FT
Variation 26°48' W.
Scale of Miles
60°25' Longitude West from Greenwich
60°25'
46°10'
P.C.
P.C1.
L.C1.
L.C2.
C2.
Tr.

and the large amount of basic volcanic rock on the island renders most improbable the presence of iron ore in workable quantity.

Greener or Ingraham Areas.

Situation and character of openings.—The Greener or Ingraham areas are in the lower hill country, near the shore, two miles south-west of Barachois. The rocks here belong to the lower Carboniferous and the Cambrian.

The work done on these areas consists of several excavations, one of which is 25 feet long, 12 feet across and 30 feet deep. From this pit, which may be called pit No. 1, some 500 tons of ore were extracted in 1900 and shipped to the Dominion Iron and Steel Company's furnaces at Sydney. As at present exposed there seem not to be very distinct walls enclosing the ore body, as hematite is found impregnating the country rock, which is a gray limestone with some greenish slate in close proximity. However, the large number of open cavities, lined with crystals, indicates the superficial character of the deposition. The ore appears pure to the naked eye. In 1906 work was resumed and a tunnel driven some 60 feet in length, at the end of which the ore pinched to about one foot. The deposit is, therefore, to all appearances, comparatively small.

A second excavation, pit No. 2, is very different, the iron ore being sometimes blackish spathic ore and sometimes a massive hematite. This deposit appears to be the replacement of a definite bed.

There are several other openings and test pits in this area, which generally show the deposits of iron ore to be either in the limestone or in the green slate, but always close to the contact of the two rocks.

Analyses.—

Sample 171.—Ore from No. 1 pit, from across the north face of the workings, excluding the rock portion.

Sample 199.—Ore from a dump, from recent work.

Sample B–1.—Average of all shipments made to Sydney during the working of pit No. 1.

Sample B–2.—Ore from bottom of pit No. 1; Nova Scotia Steel and Coal Co.

Sample B–10.—Average of No. 2 pit, March, 1907; Nova Scotia Steel and Coal Co.

Sample 173.—General sample from the central six feet of trench No. 2.

Samples 177 and 178 are analyses of samples from other openings and test pits on the property.

	171	199	B–1	B–2	B–10	173	177	178
Fe	40.52	48.700	44.43	49.50	33.20	38.29	43.58	32.62
SiO_2	....	4.620	16.10	14.56	20.00	....	....	....
Al_2O_3	....	1.900	....	....	....	....	....	....
CaO	....	9.250	....	4.07	15.00	....	....	....
MgO	....	.680	....	....	....	....	....	....
P	....	.065	....	....	....	....	....	....
S	....	.087	....	....	....	....	....	....

Summary.—The iron ore of this part of Barachois appears to be a series of contact deposits at and near the junction of the two formations. As such, the units bid fair to be neither very large nor very continuous. One or two at least are known from actual operations to be of such size as to make ore shipments profitable. Others may later exhibit a like strength; but it is improbable that single deposits of great extent will be found, for the character of the walls and the shape of the ore bodies give no prophecy of it.

McPherson Areas.

Location and rock distribution.—The eastern ores and country rocks are very different from those nearer the shore. The Boisdale hills are a mountain axis of Pre-Cambrian age, composed of several varieties of rocks, igneous and sedimentary; and against this the younger strata lie. This axis extends for many miles, from the mouth of George river on the north-east to East bay on the south-west. It contains granites and, in places, a large development of metamorphic magnesian limestone, which has long been called the George river limestone, and its associated rocks of the George river series. The large dolomite quarries of the Dominion Iron and Steel, and Nova Scotia Steel and Coal Companies at George river are in this series. Apparently the limestones at Whycocomagh, in proximity to which the hematite and magnetite occur, are of the same age.

In this part of the Boisdale hills the granite, at least in part, intrudes into the limestone, and at the north-east cuts off some of the iron ore contained in the latter. In places also, some little dark trap is encountered, in both granite and limestone, and this has some influence upon the iron minerals.

Magnetite deposits.—The hills contain magnetic ore in many isolated localities, which as a whole follow the general trend of the upland north-east and south-west; and it has been reported for a number of miles south-west of the deposits about to be described.

These begin at the north side of the Barachois road across the mountain, and extend, probably intermittently, north-east for a mile. Ore has also been reported south of this road, but investigation of such openings as could be found for a mile south-west failed to discover any.

Immediately north of the road are five pits. The iron from all of them is a black to purplish black, finely crystalline magnetite, in many places showing a considerable quantity of pyrite. Thus the sulphur content is likely to be high, not uniformly, but in some shipments. There is a large amount of lime mixed with the ore, in part as horses of the old limestone country rock, in part as a very recent calcite vein deposit.

The limestone is impure, often containing serpentine, as in the quarry at George river. Its structure is not well defined, but apparently it strikes roughly north-east, standing perpendicular or with a high north-west dip.

A number of pits and excavations have been made in these areas, the main one consisting of a trench in the side of a low hill, 12 feet square and

PLATE 63.

(*a*) Skye Mountain from the north-east, showing elevation of land holding Drummond iron workings.

(*b*) Little Bras d'Or lake from near the McPherson iron Field.

with a face approximately 25 feet high. Generally speaking it may be said that the ore is very irregularly distributed in stringers and pockets, which are likely either to swell or pinch out within a very short distance. It is reported that in places these attain widths of three feet of clean ore, but in most of the points where the veins are visible they do not exceed 12 to 15 inches.

Analyses.—Sample 166 is made up of ore taken in part from a pit which exposes two small veins and in part from the dump.

Sample 165 is from a dump of ore taken from the main excavation, and 127 is from a dump resulting from work done in May, 1907.

Shipments of this ore to Sydney have given the following analyses:—

No.	Fe	SiO_2	Al_2O_3	CaO	MgO	MnO_2	P	S
A–12 ..	54.00	....	....	....	....	....	trace	6.180
A–13 ..	57.12	....	....	....	....	....	....	.472
A–14 ..	56.40	5.56	....	....	....	....	trace	.214
A–15 ..	55.64	5.66	....	....	....	....	trace	.396
A–16 ..	51.96	9.22	....	....	....	....	trace	.374
A–17 ..	36.53	11.14	....	....	....	....	.020	.500
A–18 ..	62.90	....	....	....	....	....	trace	.204
A–19 ..	47.46	11.44	4.14	1.643	5.755	.004	.007	.209
A–20 ..	58.42	7.66	....	....	....	....	.012	1.470
A–21 ..	51.51	9.03	....	....	....	....	.137	....
A–22 ..	51.80	9.83	....	....	....	....	.137	....
A–23 ..	51.11	10.17	2.13	.403	4.032	.600	.015	1.940
165. ...	48.380	9.60	2.120	2.150	8.620	....	.040	.254
166. ...	30.40	....	....	....	....	....	....	....
127. ...	55.470	7.06	1.960	.300	9.160	....	.030	.024

Other analyses, from various openings on this area, gave results varying between 25 and 50% of metallic iron.

Summary of conditions.—The conditions under which the iron ore occurs here are much like those prevailing at Skye mountain, Whycocomagh. The limestone when shattered appears to form a good receptacle for the ore, which has in part filled fissures, in part has replaced the country rock. These fissures, resulting from strain in the process of uplift of the mountain, follow its trend in a general way; hence the rough alignment of the ore bodies. In all probability ore need not be expected in the granites. That in the trap at the north-eastern end of the range is too high in sulphur, and what may now be seen gives little encouragement for prospecting further in that direction, unless it can be shown that the intrusive rocks cease to affect the limestone as one goes nearer to George river.

On the other end no iron ore is known for a very considerable distance south-west of the trans-mountain road, although reported some miles farther down the lake.

It is plain that, as a whole, the ore bodies will be found most frequent where the limestone is most free from igneous influence. Also it seems from the evidence that exceedingly large single bodies need not be expected; but units capable of yielding many thousands of tons of good ore are likely to be found at various places along the strike of those now known. That portion near the road is of good quality and its body is encouraging. The indefiniteness of shape and the character of the walls create, however, a constant uncertainty in mining.

But with all these drawbacks, districts such as this are more or less encouraging as shipping propositions, capable of being handled without much capital, the ore being delivered under contract to a smelter. There are undoubtedly many other districts which would, with proper exploration, turn out to be available for such use.

For surveying this territory accurately a magnetometer might be employed, except at the north-east end. There the pyrrhotite would destroy the accuracy of the work. The ground is in some ways not an easy one to subject to this treatment, owing to the indefinite shape and boundaries of the deposits and to the disseminated magnetite grains in the limestones. On the other hand, the ore bodies all trend nearly in the same direction and are approximately vertical, and the topography is even.

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