GM 08392

GEOLOGICAL REPORT FOR THE YEAR 1942

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GM-8392

GEOLOGICAL REPORT FOR 1942

by

J.A. Retty

Montreal, Que.

April 30, 1943.

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ACCOMPANYING MAP

NEW QUEBEC SHEET (GEOLOGY)

Scale: one inch to two miles

PART I

GENERAL INFORMATION

INTRODUCTION (SUMMARY)

This report describes an area in New Quebec covered by Special Development License No. 4676 which has been granted to Hollinger North Shore Exploration Co. Ltd. An account of the various phases of exploration is included, and the general features of the region that are of economic interest. The geology is discussed and a recapitulation of the rock types is given, with what is now known of their mutual age relationship and attitude. A complete review of the iron ore occurrences is included, and a description of the "gossan area". The possibilities for the discovery of additional ore deposits are stressed.

HISTORICAL BACKGROUND

Geologic mapping, topographic mapping and prospecting were carried out in the area in 1939. Operations were suspended in 1940. They were resumed during the field season of 1942, when Hollinger North Shore Exploration Co. Ltd., a subsidiary of Hollinger Consolidated Gold Mines, Ltd., acquired the concession formerly held by private interests.

ACQUISITION OF SPECIAL DEVELOPMENT LICENSE NO. 4676

In the summer of 1937, while in charge of field work for Labrador Mining and Exploration Co. Ltd., the writer located a number of gossans on the upper part of the George River (west branch) in New Quebec. During the field season of 1938, in the course of work for the same company, on the Ruth Lake Deposits of iron ore, the writer discovered the Burnt Creek Deposit of manganiferous iron ore in New Quebec. In the winter of 1939, because of these discoveries and upon the advice of the writer, a private group applied for and secured from the Department of Mines of the Province of Quebec, the exclusive right to prospect in an area covered by Special Development License No. 3432. This license was eventually allowed to lapse.

In the spring of 1942, Hollinger North Shore Exploration Co., Ltd., a subsidiary of Hollinger Consolidated Gold Mines, Ltd., was granted Special Development License No. 4676, covering the area formerly included in Special Development License No. 3432.

DIRECTORATE

The Board of Directors of Hollinger North Shore Exploration Co., Ltd., is now constituted as follows:

President:	Jules R. Timmins
...	
Directors:	P.C. Finlay
	C.F. Farwell
	B.M. Evans
	L. Mizgala
...	
Secretary:	P.C. Finlay

The executive office of the company is located at Suite 721, Royal Bank Building, 360 St. James Street West, Montreal, Que.

CHANGE OF MANAGEMENT

Mr. John Knox, General Manager of Hollinger Consolidated Gold Mines, Ltd., has been appointed General Manager of Hollinger North Shore Exploration Co. Ltd.

The work of 1939 in New Quebec was in charge of the writer. When Hollinger North Shore Exploration Co. Ltd. was granted Special Development License No. 4676, Dr. J.K. Gustafson of the staff of Hollinger Consolidated Gold Mines, Ltd., was put in charge of operations. The writer, because of his lengthy association with the project, was engaged as assistant, and also acted in an advisory capacity.

The preparation of this report and the accompanying map has been entrusted to the writer, owing to the resignation of Gustafson to accept a wartime position with the Metals Reserve Company of Washington, D.C.

LOCATION AND AREA

The area included in Special Development License No. 4676 is described by the Department of Mines of the Province of Quebec as follows:

"A block of land situated immediately to the north of the watersheds, which form the dividing line between the Labrador and the New Quebec territories, at the north end of the chain of Lakes Attikamagen, Petitsikapau, Dyke, Marble, etc., at the headwaters of the Hamilton River, as indicated on the geological map of the New Quebec Territory, published in 1929 by the Department of Roads and Mines, Mines Branch".

"This block of land, comprising an area of 3,900 square miles, may be more particularly described as follows, to wit: 'commencing at a post four feet high, bearing the following inscriptions:- "North-eastern angle, License No. 3432, under date of February 1st, 1939, J.A. Retty", planted on the west shore of the discharge of Lake Advance, at the headwaters of the George River at the extreme north of said lake, indicating the northeast corner of the said area; thence in a west direction astronomically, a distance of one hundred (100) miles; thence, in a south direction astronomically, a distance of thirty-five (35) miles; thence, in an east direction astronomically, as far as the height of land mentioned above; thence, following the said height of land as far as an imaginary line drawn in a south direction astronomically from the point of beginning.' "

INACCURACY OF BOUNDARY

From the above description it is evident that the boundary of Special Development License No. 4676 hinges upon:

1. The location of a post placed by the writer on the west shore of the outlet of Advance Lake, in 1939, pursuant to instructions received from the officials of the Quebec Department of Mines.

2. The geographical position of the height of land.

The location of Advance Lake and of the height of land is not accurately known. These have been placed on the existing maps from rough sketches, as those parts of the region where they are shown have never been surveyed. Field work now indicates that the true position is considerably different from the location represented on the existing maps. If the maps were accurate, the area as now shown would cover the ground originally requested. But, owing to the change in location of the present geographical ties indicated by preliminary surveys, it will be necessary to revise the description when accurate surveys have been made. This will be essential in order to define accurately the boundary of the ground originally granted and thereby eliminate the error resulting from the initial unavoidable lack of geographical knowledge.

ACCESSIBILITY - TIDEWATER BASES OF OPERATION

Gulf of St. Lawrence

Two take-off points have been used for air travel to the area from the Gulf of St. Lawrence. They are located at Moisie, Que., and Havre St.-Pierre, Que., on the North Shore.

Moisie is a village of 200 people situated at the mouth of the river of the same name, some 325 miles below Quebec and 14 miles east of Seven Islands, Que. The population of Seven Islands is 700. It has three general stores, one of which is owned by the Hudson's Bay Company. It also has an excellent harbour and wharf. The main occupations of the inhabitants are fishing and lumbering. There is an Indian reservation at the west end of the village. A regular boat service between Seven Islands and Rimouski is maintained by the Clarke Steamship Company during the season of navigation. Rimouski may be reached by overnight journey from Montreal via the Canadian

National Railways.

The distance from Moisie to the interior base at Sandgirt Lake is 265 miles. Moisie was the take-off point for the expedition of 1939. It has the advantage of being comparatively accessible and having more frequent boat service and better stores than Havre St.-Pierre. Another advantage is the basing of planes in fresh water. Fresh water is much to be preferred to salt water, as the latter corrodes the pontoons.

The great disadvantage of this take-off point is the height and rugged character of the hills to the north. These hills rise to heights of 4,000 feet within fifty miles of the Gulf of St. Lawrence. In order to have a reasonable factor of safety in crossing these hills, it is necessary to climb to 6,000 feet. The fogs of frequent occurrence along the hills render flying hazardous and often impossible. For this reason it was decided to use Havre St.-Pierre during the past season.

Havre St.-Pierre is on the North Shore of the Gulf of St. Lawrence, some 400 miles below Quebec City and directly north of the central part of the island of Anticosti. In normal times a weekly boat service between Montreal and Havre St.-Pierre is maintained during the season of navigation. Owing to the submarine menace during the past summer, this service was considerably disrupted. The situation made problems of travel and supply very difficult.

The village has a population of 1,200. It is the seat of a bishopric, and institutional buildings include a hospital, a convent and a normal school. There is only one large store in the place, and the choice and items of goods are very limited. There is an excellent harbour and wharf at this point.

The distance from Havre St.-Pierre to the interior base is 265 miles - the same as from Moisie. The great advantage of this point as a base on the Gulf is the lower topographic character of the hills to the north. The rise is more gradual and elevations are in the neighbourhood of 2,500 feet. Fog clears much more quickly, and the factor of safety in flying is much greater than at other points along the Gulf.

The above considerations prompted the writer to suggest the use of Havre St.-Pierre as a base during the past field season. However, the difficulties of communication are now such that it would not be advisable to use this point as a base until such time as the situation is remedied. One disadvantage of this location is the basing of planes in salt water. The corrosive action of salt water on pontoons has already been mentioned.

The Dominion Government maintains a telegraph line along the North Shore from Quebec to Blanc Sablon. Communication with outside points thus constitutes no problem.

Atlantic Coast

There is an alternative base on tidewater at Northwest River, at the head of Hamilton Inlet, Labrador. Northwest River is the name of a village of 250 people, having a Hudson's Bay post and a Grenfell Mission, with wireless facilities.

The distance from Northwest River to the interior base at Sandgirt is 217 miles, 48 miles less than either of the routes from the Gulf of St. Lawrence. It has the added advantage of having more favourable flying weather than the route from the Gulf, where low-lying clouds and/or fog often render flight impossible or extremely hazardous. This place, however, is very isolated. It is serviced every fortnight through the summer months by "S.S. Kyle", a Government freighter plying between St. John's, Nfld. and Hopedale on the Labrador coast.

METEOROLOGICAL STATION AT NORMAN LAKE

During the winter of 1942, the Dominion Government established a meteorological station at Norman Lake, which lies within the Province of Quebec, just east of the Romaine River and 115 miles north-northwest of Havre St.-Pierre. This location is close to the direct route between Havre St.-Pierre and Sandgirt Lake. The spot was very convenient for the operations of the Labrador company (Labrador Mining and Exploration Co. Ltd.) as it was often used as a refuge in unfavourable weather, as a refueling station and as a relay point for freight and radio messages.

PART II

DESCRIPTION OF OPERATION

PREPARATIONS FOR EXPEDITION

The matter of personnel was largely attended to by Gustafson. Three geologists, two prospectors and a clerk were transferred from the Hollinger organization. One geologist, ten prospectors and two canoemen were hired. The writer engaged two canoemen, a cook, a handyman and a chore boy, the last three having been members of earlier expeditions.

The food, camp equipment and instrument lists were prepared by the writer on the basis of the standard requirements for such expeditions. These materials were purchased largely in Montreal. The preparation of maps, prints and so forth was also looked after by the writer.

PERSONNEL

The following men made up the personnel of the expedition:

Chief Geologist: J.K. Gustafson, Ph.D.

Assistant: J.A. Retty, Ph.D.

Base Camp:
- Clerk: H. Montgomery
- Cook: O. Ryan
- Chore boy: L. Arsenault
- Handyman: J.A. Gauthier

Radio Operators: (salary of two paid by Dominion Government)
- Halliday, J.
- Hogle, K. (Came in August; salary paid to end of season)
- Gardner, D. (left in August)
- Magee, F.V. (came in September)

Field Force:

Geologists:
- W.H. Hansen, B.A.Sc.
- A.T. Griffis, Ph.D.
- A.E. Moss, Ph.D.
- D.E. Whitmore, M.Sc.

Canoemen:
- Laporte, M.
- Marion, L.
- McCleery, A.
- Vezina, A.

Prospectors:
- Armstrong, J.
- Berry, L.
- Bones, O.
- Connolly, E.
- Frederickson, E.
- Garvey, W.
- Gauthier, A.
- Gauthier, A.S. (Died at Bruce Lake, on September 8th, 1942)
- Girard, N.
- Martin, R.
- McNeill, J.E.
- Swanson, P.

Flying (Interior) personnel based at Sandgirt:

Pilot: D. Murray (away for one week, replaced by Holden and Hollinsworth)
Mechanic: E. Bouchard

Engineer: Changed several times - Crewe, Gow and others.

Freighting by air from Havre St.-Pierre and Norman Lake:

Pilots: Jones, Delamere, Holden, Padgett, Murray, Roy, Gray, Gauthier.

Mechanics: Andoney, Gow, Crewe, Vignault, Bijould, Carter, Brown.

ACKNOWLEDGMENTS

Efficient assistance is indispensable to the success of any operation. The company was very fortunate in securing the services of competent, energetic and loyal geologists, whose work contributed very materially to the success of the expedition. Grateful recognition is due these efficient colleagues for their assistance in extending the geological mapping of the region. This also applies to the prospectors, whose untiring and sustained efforts in the search for ore

deposits are much appreciated.

Special mention is due Pilot Don Murray, of Quebec Airways, Limited, who was in charge of interior flying. He was energetic, competent and really interested in doing his job well. The writer wishes to express his extreme gratitude to Murray for his splendid performance.

INTERIOR BASE

During the course of the summer of 1936, a location for a permanent base was chosen at Sandgirt Lake for work in the Labrador concession, and a gasoline cache made there. This particular point was selected because it was an ideal seaplane base, with a sandy beach in a sheltered spot, because it was practically in the centre of the Labrador concession and because it was very close to the south end of the Labrador trough.

A cookery, a store house, a root house and a radio shack were erected there in the summer of 1937, and in 1939 a log building, which served as an office.

A temporary camp was set up at Sawyer Lake in 1938, when the Sawyer Lake iron ore deposit was stripped, trenched, test-pitted and channel-sampled.

In 1939, operations in the New Quebec Area were carried out from the Sandgirt base. In the summer of 1942, Sandgirt was again used as the base. At the beginning of the season, when work was being done in the southwest part of the Labrador concession, the location was quite suitable, but as operations progressed and were concentrated in the northern part of the Labrador concession and in the New Quebec Area, it was found that much valuable time was lost flying to and from the various parties. Neither the time nor the aeroplane transportation was available for shifting the base during the middle of the season. Plans are now being made for doing so at the beginning of the next field season.

RADIO

The station is owned by Labrador Mining and Exploration Co., Ltd. It is operated by the Meteorological Service of the Department of Transport, Ottawa.

Communication is maintained with Seven Islands, Que., and Goose Bay, Labrador, where daily weather reports are forwarded. The facilities of this station were made available to Hollinger North Shore Exploration Co. Ltd. for sending out messages and maintaining watch over the aircraft on interior flying. The operators also act as caretakers of the equipment and supplies stored at the Sandgirt base.

The radio shack and all radio equipment therein was destroyed by fire on December 23rd, 1942. Arrangements are being made for replacing the equipment and re-establishing the station. It is hoped that the service will be resumed shortly.

FLYING

When work was initiated in Labrador in 1936, Newfoundland Skyways, a partially-owned subsidiary of Labrador Mining and Exploration Co. Ltd., purchased two Bellanca "Skyrockets" in the

United States. These seaplanes were second-hand and were allowed to enter Newfoundland territory duty-free. In 1936, 1937 and 1938 these machines were used on interior flying and freighting. In 1939, one seaplane (VO-BCD) being considered unfit for further service, was dismantled. A replacement was chartered from Dominion Skyways, and transportation was carried on as before, with two aircraft.

Shortly after the beginning of operations, Pilot C. Frechette and Radio Operator Gaynor were lost in Aircraft VO-BDF. When the seaplane was located it was found to be almost a total loss. After a lapse of time a second seaplane was chartered from Dominion Skyways for the remainder of the season.

Newfoundland Skyways, owing to the dismantling of one seaplane and the loss of the other, was left without any aircraft. The remaining assets of the company were purchased by Labrador Mining and Exploration Company, Limited, in February, 1942. During the period when Newfoundland Skyways operated its own seaplanes, the average cost of all flying was $70 per hour, a figure considerably lower than the overall rate during the past season. During the past season all flying was purchased from Quebec Airways, Limited, a subsidiary of Canadian Pacific Air Services. Freighting from Havre St.-Pierre was on a poundage basis, while interior flying was on a charter basis.

The freight rate by air from Havre St.-Pierre to the Sandgirt Base was 47 cents per pound, and the passenger rate $80 per return trip, plus transportation tax of 10% at the beginning of the season and raised to 15% during the latter part of June. Interior flying was on a charter basis, the rate being from $50 to $70 per hour, depending upon the type of machine used. The cost of freighting gasoline used on interior flying must be added to the interior rate. This amounted to an added $108 per hour (Gasoline, $4.50 per gallon; hourly consumption 24 gallons). The total cost of interior flying in the New Quebec Area was $178 per hour.

ORGANIZATION

As in previous years, the central base camp at Sandgirt Lake was the focal point of the operation. The members of the expedition, freight and camp equipment were ferried there by aeroplane from Havre St.-Pierre. From this point the field parties were equipped, on the basis of lists prepared by the writer, and flown to different localities at which they worked. Supervising and provisioning were done weekly, using ration lists prepared and revised over a period of years in view of the requirements of the operations.

Field work in the New Quebec Area (Special Development License No. 4676) on behalf of Hollinger North Shore Exploration Co. Ltd., was carried on from the Sandgirt base.

METHOD OF MAPPING

The available topographic maps are of little value except in their major features, and prior to the work of the writer much of the area had not been mapped or even roughly sketched.

Surveys have been made by range finder and Brunton compass, and aerial sketching has been done extensively. Before assigning a party to field work in an area, it was examined and sketched from an aeroplane, so that the party had in advance a rough map of the water course, and it was comparatively simple for an experienced man to plan work in advance and arrange a meeting place on a lake suitable for landing the aeroplane.

The field personnel worked in two-man parties. It has been found that two-man parties can work more efficiently, are provisioned more easily and can be shifted much more rapidly by plane than larger parties. The geologist had a canoeman as helper, the prospectors worked in pairs.

BRIEF REVIEW OF FIELD WORK

1939 - Geological Work and Prospecting from Sandgirt Base

One geological party and one prospecting party worked for part of the season in New Quebec. Operations were greatly impeded by the loss of a plane and its two occupants, Pilot C. Frechette and Radio Operator E. Gaynor.

1940 - Operations Suspended

1941 - Operations Suspended, Sandgirt Base Abandoned

1942 - Geological Work and Prospecting from Sandgirt Base

Geological Work

Geologists were instructed to make a rapid, general examination of the rocks in order to cover the country as quickly as possible. They were advised that speed in reconnaissance is essential, but that points of potential economic interest were to be examined in detail. The sole object of the work was to locate favourable areas for prospecting.

During the past field season ~~four~~ three geological parties operated in the New Quebec Area. The name of the chief of the party and the area covered by him follows:

A.T. Griffis: Griffis mapped the upper part of the George River (west branch) as far as the big north bend. He then worked southeast to and including Arjay Lake.

W.H. Hansen: Hansen mapped a new lake north of the upper part of the George River (west branch) - Retty Lake - and went downstream as far as Hansen Lake, which he mapped in great part.

D.R.E. Whitmore: Whitmore continued the work on the upper part of the Swampy Bay River, tying his survey into the mapping of the Labrador concession on Petitsikapau Lake.

The work outlined above consisted of range finder surveys of the waterways,in the course of which geological observations were made. This mapping was supplemented by land traverses, which added greatly to the knowledge of the geology.

Prospecting

Four parties of experienced, well-trained prospectors carried on the search for economic minerals within the New Quebec Area during the past season. They were placed in areas which appeared to be most favourable to the occurrence of ore deposits, and in the course of the summer were shifted, when the possibilities of rapid discovery appeared to have been exhausted or very slight, or when more promising ground was located. They were instructed to cover the area quickly, in the hope that any large, topographically-prominent or otherwise conspicuous mineralized outcrop would be easily located. Their work was supplemented by aerial observation, which helped in locating much favourable ground.

The names of the prospectors and the area which they covered follows:

Eric Frederickson and Ellard Connolly prospected the area adjoining the lakes at the headwaters of the George River (west branch).

The late A.S. ("Phil") Gauthier and Lorne Berry examined the area surrounding Retty and Hansen lakes.

Pete Swanson and Ollie Bones worked on the area included between Louis Lake and Volcanic Lake.

J.E. ("Bob") McNeill and Norman Girard prospected around McNeill Lake and down the George River (west branch) to and including Girard Lake.

PART III

FEATURES OF SPECIAL INTEREST

PREVIOUS WORK

The late A.P. Low, of the Geological Survey of Canada, carried out the first geological and topographical investigations within the region in 1893 and 1894. The maps and reports on the extensive iron-bearings series were incorporated in a general report on the Labrador Peninsula, published by the Dominion Government (1). Copies of this report are available for perusal at the library of the Geological Survey at Ottawa. Low's work, though purely of a reconnaissance nature, was a general guide in the present investigation and is invaluable as a starting point.

In 1929, Drs. W.F. James and J.E. Gill directed prospecting operations within the region for the New Quebec Company. Through an arrangement with this company, the field notes, sketches and final report were made available to the writer. The data, although sketchy, have proved very useful in continuing the work.

In 1933, Dr. J.E. Gill investigated reported gold discoveries in the southwest part of Newfoundland-Labrador. The results of the geological work are published in the proceedings of the Geological Society of America in a joint paper by Gill, Bannerman and Tolman (2).

Prior to the work of the writer from 1936 on, no systematic large-scale topographical or geological mapping, and very little prospecting, had been carried on within the region.

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(1) Geo. Survey Can. Ann. Rep. (New Series) Vol. VIII, 1895, pp.1L-387L.
(2) Geo. Society of Am., Vol. 48, Pt.1, 1937, pp.567-585.

PHYSIOGRAPHY

The area is included in the large, roughly U-shaped terrain of Precambrian rocks surrounding Hudson's Bay, commonly known as the "Canadian Shield" of the "Laurentian Plateau".

The surface of the country between the Gulf of St. Lawrence and the interior presents a very sharp contrast in topography. For a distance of about 100 miles, the land is very rugged. The plateau has been markedly incised by turbulent streams. Canyons as much as 1000 feet deep are present along the Moisie and other rivers flowing south. A range of hills with a maximum elevation of 4,000 feet (approximately) crosses the country in an east-west direction some 50 miles north of Moisie. This gradually slopes northward to 2,000 feet, where the country becomes relatively flat and comparable in local relief to the topography of other parts of the "Shield". Eastward, this range gradually decreases in elevation. It is lower and narrower in the vicinity of the Romaine River. This is a very important feature in considering the possible route of a railroad to the iron deposits.

In the interior, the local relief is generally slight, but variations in the aspect of the country are quite pronounced.

To the east of the Labrador trough, east of Andre Lake along the Quebec-Newfoundland boundary, there is a very prominent ridge which extends northward at least thirty miles. To the east as far as the Eaton River and northward roughly to the George River, there is a large flat area covered by numerous lakes. About the headwaters of the George River (west branch) and in the area to the north there is a series of prominent parallel ridges trending northwest. They rise to local elevations of as much as 600 feet. North of Attikamagen Lake the area is covered by numerous linear lakes and intervening ridges which trend generally northwest. Structural control of the topography is quite pronounced in this area. The ridges parallel the axis of folds.

The upper part of the Swampy Bay River lies along a valley which is V-shaped in horizontal outline. The divide between the Swampy Bay River and the Hamilton River is very irregular in outline, with long salients and re-entrants trending northwest and southeast. This lack of regularity is due to the fact that it crosses the grain of the country.

The western part of the area is drained by the Swampy Bay River. The eastern part is drained by the George River (west branch). The intervening area is drained by a river which begins in Retty Lake. It is probably the "Whale". All the above flow into Ungava Bay.

TRANSPORTATION

The vehicle of transportation used thus far in Labrador has been the aeroplane. This mode of conveyance is very costly. If there were a large volume of freight to be moved, it would effect a considerable saving in money to set up a system of water transportation from the south end of Ashuanipi Lake to the north end of Menihek Lake. Plans would have to be made well in advance, however, as preliminary preparations would require considerable time and the movement of freight would be slow during a short season.

The eventual establishment of a mining industry in Labrador will require the construction of a railroad. While admittedly there is a transportation problem, it is a much less formidable one than would appear at first glance.

The route along the Romaine River Valley from the Gulf of St. Lawrence appears to be the most favourable. The distance to the Sawyer Lake deposit by this route is approximately 310 miles. The results of observations made by the writer along this route are given farther along in this report.

There is a second possible route along the valley of the Moisie River to Seven Islands, Que. From the air, the topography appears rugged for a distance of 100 miles from the Gulf of St. Lawrence, but it is possible that a narrow fringe, sufficient for the bed of a railroad, may border along the river. The distance from Seven Islands to the Sawyer Lake Deposit is approximately 300 miles.

There is a third possible route to the area. This is from Grand Lake, which flows into Hamilton Inlet, the long indentation in the Atlantic Coast. Although shorter than the route to the St. Lawrence (distance approximately 200 miles) it is less favourable because of a shipping season of only four and one-half months.

PRELIMINARY SURVEY OF POTENTIAL RAILROAD ROUTE

In 1941, the writer made a geological reconnaissance of the lower Romaine River basin for the Quebec Department of Mines. Incidental to the work some general observations on the topography were made with a view to determining the suitability of the terrain along the Romaine River for the construction of a railroad to the iron ore fields of Labrador and New Quebec. This work has been supplemented by additional observations made during the course of aeroplane flights over the area farther north during the past field season. In the absence of a report by a railroad building expert, the results of this work are presented briefly herein. They are as follows:

1. There is an excellent harbour at Betchouane, 25 miles east of Havre St.-Pierre, which would probably be the southern terminus of a railroad along the Romaine Valley.

2. For a distance of 25 miles north of the Gulf construction along river terraces would be easy and inexpensive.

3. The next 35 miles would be somewhat more difficult, owing to the narrow character of the valley, but certainly the project would not be of the most difficult type.

4. Along the following 25 miles, the river cuts through a large mass of anorthosite. The surface is rugged, and the valley narrow, with steep-sided walls. Construction would be very difficult and expensive along this part of the route. The upper part of the Romaine River has been described by A.P. Low (1). Railroad construction along this portion to the height of land would be very easy and inexpensive, because of the terraced banks.

The elevation of the head of the river is given as 2,770 feet on a map issued by the Quebec Department of Lands and Forests in 1913, entitled "La Côte Nord du Golfe St.-Laurent, Comté de Saguenay".

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(1) Geo. Survey Can., Ann. Rep. (New Series) Vol VIII, 1895, pp.167L-170L.

There is no information as to the method used in arriving at this figure, so that its accuracy is somewhat doubtful.

From personal observations, it is known that beyond the height of land in the Hamilton River watershed there would be no serious difficulty encountered in projecting a railroad to the iron ore field.

HARBOURS

At all termini of possible railroad routes to the Gulf of St. Lawrence there are excellent harbours. These are located at Seven Islands, Mingan, Havre St.-Pierre and Betchouane. The outline of these harbours is indicated on the Admiralty charts and on charts issued by the Province of Quebec.

OBSERVATIONS OF LATITUDE AND LONGITUDE - AERIAL PHOTOGRAPHY

During the past field season, observations for latitude and longitude were taken throughout the Ungava Peninsula by the Bureau of Geology and Topography, Department of Mines and Resources, Ottawa. The object of this work was to establish control for aerial photography, carried on by the Aeronautical Chart Division of the United States Army Air Force, for defence purposes. Messrs. Eric Fry and Roy Clark were in charge of the work. Three observations were made within the area, and through the kindness of Messrs. Fry and Clark, the location and value of same are listed below:

	Latitude N.	Longitude W.
1. Sandgirt Lake	53° 54' 12"	65° 19' 01"
2. Attikamagen Lake	54° 54' 41"	66° 35' 51"
3. Michikamau Lake	54° 17' 37"	64° 62' 10"

Inasmuch as no work of this type had been done within the area previous to the past season, the information is exceedingly valuable in placing the topography already mapped. It is hoped that eventually both aerial photographs and maps will be made available to the company.

WATERPOWER

Some few rapids are present along the upper part of the Swampy Bay and George rivers, which might afford sites for a small hydro-electric development. In the areas examined, however, because of their proximity to the height of land, there is no possibility for any major installation.

Because of the probable economic interdependence of Newfoundland-Labrador and the New Quebec Area, the following information on the waterpower possibilities in Labrador is included.

The area is exceptionally adapted to the production of hydro-electric energy on a large scale. Grand Falls, one of the greatest undeveloped waterpower sites in the world, lies within the Labrador concession. It is situated on the upper part of the Hamilton River, 225 miles north of the Gulf of St. Lawrence and 175 miles west of Hamilton Inlet. The site is unsurpassed as a potential source of power.

A reconnaissance survey of the Falls was made by Low in 1894 (1).

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(1) Geo. Survey of Can., Ann. Rep. (New Series) Vol. VIII, 1895, pp.140L-142L.

Barometric readings show a sheer drop of 302 feet at the Falls with a descent of 760 feet in 12 miles below the Falls. The rate of flow was placed at approximately 50,000 cubic feet per second.

The potential energy is obviously very great. On the basis of the above data, the available electrical capacity is variously estimated at from 2,000,000 to 5,000,000 horsepower.

The Falls, moreover, could be harnessed with great ease, due to the exceptionally favourable character of the local topography. The river flows in a general southeasterly channel. After the first precipitous drop (302 feet), it takes a sharp turn to the east for a distance of one-third of a mile. It then turns southeast for one-half mile and continues in a zig-zag course for eight miles covering an actual distance of only four miles and dropping 258 feet. Throughout this length, it is flanked by a steep-walled gorge (Bowdoin Canyon). The total drop from the edge of the Falls to the end of the gorge is 560 feet. The gorge gives way to the broader, but still steep-sided and narrow valley of the Hamilton River (1).

Several small waterpower sites are present within the region, but these are not to be compared with Grand Falls.

From the above, it is evident that there is sufficient potential hydro-electric energy to fill large mining requirements with a probable surplus available for other industries.

EXAMINATION OF GRAND FALLS

During the early part of September, a cursory examination of the power possibilities of Grand Falls was made for the Aluminum Co.

(1) Opp. Cit. p.129L.

of Canada by A.W. Lash, electrical engineer, of Thorold, Ont. Lash was on loan from the Ontario Pulp and Paper Company to G.H. Acres, consulting hydro-electrical engineer, of Niagara Falls, Ont. C.E. ("Pete") Lemoine, on loan from the engineering staff of the Quebec North Shore Paper Company, Baie Comeau, Que., and three bushmen, one of whom was supplied by the Labrador Mining and Exploration Co. Ltd., completed the personnel of the party. The survey occupied a period of ten days.

The information obtained was limited by the very rapid character of the examination, but it is much more reliable than any existing hitherto. The preliminary field estimates, as given verbally to the writer by A.W. Lash, are briefly as follows:

1. The vertical drop at Grand Falls is 275 feet and not 302 feet as previously reported.

2. The flow is 35,000 cubic feet per second.

3. The available hydro-electric energy is approximately 1,250,000 horsepower.

4. The Falls could be harnessed very easily by diverting the flow of the Hamilton River northward through a chain of lakes and dropping it into the Hamilton River below Bowdoin Canyon. It might be necessary to build a cut-off at the head of the Unknown River, in order to divert the flow of that stream through Gabbro and Sandgirt Lakes. A canal and a dam might also be necessary on the west side of Michikamau Lake, in order to divert some of the flow of the Naskaupi River into the Hamilton River.

Within the Labrador concession they form a narrow strip close to the Quebec-Labrador boundary, extending northward from the south end of Andre Lake to the vicinity of Marten Lake.

Dr. A.T. Griffis, who mapped part of the area in New Quebec underlain by Keewatin-type rocks, has described them as follows:

" George River Series:

These rocks consist of andesitic pillow lavas, some massive granular, non-pillowed flow rocks (greenstones) and some associated inter-flow sediments. The trend of the series is N.45°W; the rocks dip and face northeast, and the total thickness so far mapped may be more than 50,000 feet.

Pillow Lavas:

The lavas are similar to the pillowed andesitic lavas of Ontario and Quebec. They range from fresh, dark greenish-grey, fine-grained, well-pillowed types, with pillow-rims from one-half inch to one inch wide, into massive flow rocks of the same composition.

Greenstone:

As mentioned above, this name is applied to massive flow rocks, and the rock should have essentially the same composition as the related pillow-lava. The greenstones vary from fresh, massive types. It is inferred that their composition is andesitic, and it is difficult to distinguish the coarser greenstone types from the late dioritic intrusives. This similarity of the greenstone to the diorite is at least suggestive that they are of related origin. Since the diorite dykes and sills intrude the sediments to the west, there is, therefore, a remote possibility that the George River volcanics are younger than the Huronian (?) sediments.

Inter-flow sediments:

Three types were noted, namely, black carbonaceous tuff, quartzite, and conglomerate.

Black carbonaceous tuff: this rock is nowhere conspicuous but its constant occurrence as a host rock for sulphide deposition makes this a most important member of the George River Series. The rock is always a well-bedded, dense, carbonaceous shale or tuff, and appears as an interflow sediment between pillowed lavas or between massive dioritic flows or sills. Some of it, doubtless weathered, is very high in carbon and floats in water. Of the thirteen sulphide bodies examined by the writer, all but two were in carbonaceous tuff. Six of these sulphide masses were overlain and underlain by rock that was mapped as diorite. Since the tuff horizons occur between relatively massive, competent rocks, they undoubtedly offered the easiest channel-ways for any mineralizing solutions that were working up to the surface, and were, therefore, naturally favourable places for sulphide deposition. The association of the tuff with the diorite is not, however, as conveniently explained. This association might be considered an additional point in favour of regarding the diorite in the lavas as of flow origin.

Quartzite and slate: there were several good exposures of grey to light weathering quartzite and fresh grey slate in the vicinity of Doublet Lake. These appear to be interbedded with the George River volcanics and were noted by prospectors along the strike of the formation for several miles to the northwest and southeast.

Conglomerate: on the ridge east of Faute Lake, several outcrops of good conglomerate were mapped. This conglomerate appears to rest conformably on vesicular andesitic pillow lava, and contains various pebble and boulder types ranging up to fifteen inches in diameter. Rock types distinguished in the conglomerate were an igneous gneiss and a massive greenstone or dioritic type. "

Pre-Huronian (?) Intrusive, by A.T. Griffis

" Serpentinite:

This is a dark, brown-weathering, massive to blocky or pseudo-pillowed, black, dense to dark-green, coarse-grained basic intrusive. It is identical in appearance to serpentine rock that is found elsewhere in the Shield and has probably been derived from a dunite. It is usually found in sill-like masses or dykes, and, although it has not been found definitely cutting the lavas, is very probably an intrusive.

In several places, magnetite is found as narrow stringers in the serpentinite, and it is believed to be genetically related to it, as these stringers were not seen in any other rocks. Narrow veinlets of picrolite, the very harsh variety of asbestos, have also been observed in the serpentinite. At McNeill and Girard lakes, where the rock has been sheared and carbonated, it has become talcose, and narrow talc veins are found in it. "

Huronian-type Rocks (1)

Quartzite: Kivivic Lake

To the west of Kivivic Lake, the lowermost member of the sediments within the Labrador trough is a narrow bed of quartz-pebble conglomerate which rests unconformably on the ancient gneisses. It merges upward into a quartzite. This conglomerate is composed of vitreous, subangular pebbles up to one-half inch across in a fine, siliceous matrix. Where observed at another point, the base consists of a four-foot bed of arkose. This is of particular interest, as a thick bed of arkosic grit extends from the east of Sawyer Lake north-northeast to the south side of Snelgrove Lake. It is near the area of gneisses which lies beyond the eastern side of the Labrador trough. This thick bed of arkose may be the stratigraphical equivalent of the narrow band of arkose on the west side.

The overlying quartzite varies from white to pale pink to grey. Cherty facies are common. Whether or not this is the same quartzite that occurs higher in the section is not yet known. For this reason, it is mentioned specially. Limestone underlies the white quartzite in the Ruth Lake section, but it is quite conceivable that the limestone occurs in lenticular bands within the quartzite, and for this reason, the two quartzites may be the same. The Kivivic Lake quartzite is overlain by iron formation. The white quartzite in the Ruth Lake section is overlain by a narrow band of brown slate, and the brown slate is overlain by iron formation (see table of formations).

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(1) For completeness, a description of the regional features is included.

Dolomitic Limestone

A light-coloured carbonate rock which varies in composition from limestone to dolomite outcrops at many points within the region. In the Ruth Lake section, it underlies the white quartzite. The colour varies from bluish-white to buff to rusty brown. The texture is very fine and the fracture conchoidal to irregular. Stylolites were observed in places within the rock. At some localities, it is very pure and has the appearance of lithographic limestone. At other localities, cherty fragments occur in nodules, lines and discontinuous bands up to two inches thick. Reticulating quartz veinlets which stand out on the surface are also found.

An extraordinary limestone breccia of tectonic origin was observed in several outcrops along Astray Lake. It is composed mainly of angular fragments, and, in places, blocks of both buff and bluish-white limestone, ranging in size from a fraction of an inch to three or four feet long. In the space between the blocks, smaller angular fragments of black chert occur in a carbonate matrix.

This breccia was probably formed in the vicinity of one of the large thrust faults which occur within the region.

The writer inclines to the view that these limestones probably occur as lenticular bands within the quartzite. This view has been confirmed by observation on the ridge west of Attikamagen Lake. Other supporting evidence is suggested by the fact that no outcrops of this rock have been found in the Labrador trough within ten miles of the western margin, although rock exposures are abundant in the northwest part of this area.

Limestones occur intermittently across the Labrador trough.

Quartzite Breccia

The quartzite breccia is not a separate member of the section. It is the lower part of quartzite lying directly above. Because of its very general occurrence and distinctive appearance, it is an excellent horizon marker, and for this reason, is mentioned specially. The best exposure found thus far occurs on the west face of the ridge to the east of Slimy Lake.

This type lies in a zone 50 to 150 feet wide at the bottom of the quartzite. It is not a tectonic breccia but is composed of angular, subangular and roughly rounded fragments of a dense, chert-like substance varying in colour from grey to brown and black, embedded in a matrix of dark grey, glassy quartzite. About 20% of the rock consists of fragments ranging in size from one-quarter inch to one and one-half inches across. Some of these fragments are agates. Many of the fragments, however, are marked by a unique structure. They are roughly circular (though not always) and composed of successive layers of silica deposited in rhythmic or concentric bands, each band having a jagged or scalloped edge. The cause of this peculiar pattern is unknown. It may be due either to the colloidal deposition of silica or to some organic agency.

This rock was observed at several points along the western part of the trough.

Quartzite

The series of parallel ridges in the Ruth Lake area consist, in great part, of quartzite. Exposures are also plentiful in other parts of the region. The high hills are usually held up either by quartzite or iron formation, or both, because of the comparative resistance of these rocks to erosion.

The quartzite is massive, dense and fine-grained. It is typically greyish in colour, but is also quite glassy in places. No iron mineral was observed within this quartzite. This is a significant and important feature, as the rock is thus easily distinguished from the conglomeratic quartzite higher in the section, which always contains some iron mineral (Magnetite, hematite or limonite).

White quartzite, greyish granular quartzite and impure quartzose rocks (greywackes) occur in what appear to be continuous bands throughout the area covered by the Labrador trough, as indicated on the accompanying map-sheet.

Brown Slate

This rock occurs as a narrow band underlying the iron formation. The usual fissility of slates is found in this type and it is characterized by a distinctive brownish colour due to the presence of finely divided siderite or of one of the hydrated oxides of iron - limonite turgite or goethite. Analysis may reveal that the iron content is sufficiently high to include this slate in the "iron formation".

The rock is of very general distribution. The best exposure in the Ruth Lake area can be traced continuously for over a mile. It is approximately 75 feet thick. At Attikamagen Lake, the bed reaches 150 feet in thickness and occurs intermittently along a distance of five miles. At this point, the rock is characterized by a unique type of fracturing. The laminae are coarse, and numerous cross fractures impart to the rock a fragmental but regular pattern of roughly rectangular blocks resembling crushed road-building material. It is more properly a "pelite" than a true slate. The content of manganese was found to be 0.9 per cent.

Iron Formation

This is the most important lithologic unit within the section because it is the horizon at which the deposits of iron ore have been discovered. It is of very general distribution, having been found intermittently throughout the length of the Labrador trough, which extends from the Koksoak River in New Quebec (and possibly farther north) to the upper basin of the Hamilton River in Newfoundland-Labrador - a distance of 300 miles.

Two types of iron formation are present. One has been termed "cherty iron carbonate" after Lake Superior usage. The other consists of ferruginous chert with one or several iron oxides. These different types are considered stratigraphical equivalents, the latter having been derived from the cherty iron carbonate by processes which will be discussed later.

The iron formation observed on the western margin of the trough within the sediments consists of a variety of cherts generally characterized by the presence of iron carbonate (siderite). These cherts are bedded and dense. They vary in colour from grey to bluish grey. The fracture is conchoidal. The iron carbonate occurs in nodules up to one-half inch across, in lenses and in continuous bands with chert lenses. A small amount of hematite is occasionally found in some of the outcrops. The weathered surface is everywhere characterized by the presence of a soft coating of red iron oxide. This carbonate type appears to occur mostly in the western part of the trough. It was observed only in one area along the central part, along the southwest arm of Petitsikapau Lake.

The second type of iron formation, by far the more common, occurs along the central and eastern parts of the trough. It consists of alternating bands of ferruginous chert and hematite. The bands vary in width from one to three inches, though at some localities, the width of the hematite bands is much greater. In some places the hematite forms as much as 70 per cent of the rock, while at others, the content decreases to as little as 30 per cent (50 to 20 per cent iron).

The individual bands are sometimes continuous or "straight-bedded" (regularly laminated). They are also found in discontinuous lenses known as the "wavy-bedded" or lenticular type (irregularly laminated). Very often the bands are brecciated and recemented with hematite. Wavy-bedded and brecciated iron formation is much more common than the straight-bedded type.

The hematite bands are usually fine-grained, dense and bluish-grey. (The term "specular" is used by Lake Superior geologists for this type of rock, the platy variety being referred to as "micaceous hematite"). Sometimes, however, the hematite is reddish; less often the oxide is hydrated when it is brown, or reddish-brown. There is a small amount of magnetite present generally. Microscopic examination reveals that a small amount of ferruginous chert is often present in the hematite, the latter replacing the chert.

The chert bands vary much more in character than the hematite. The usual type of chert is dense and red, due to the presence of finely divided iron oxide. In many places, however, it is pink, due to a decrease in the content of iron, and at some localities, it is light grey, due to the absence of iron. Where the content of iron oxide is very high and the chert has become crystalline and brilliant red, it is known as "jasper" and the striking type of rock produced by the alternations of jasper and hematite bands is known as "jaspilite".

The ferruginous cherts at Attikamagen Lake possess a finely granular structure resembling the "taconites" of the Mesabi Range in the Lake Superior Region. A small amount of a greenish mineral is present, which may be greenalite. The writer's former assistant, E.W. Greig, has identified, in thin section, greenalite from the Ruth Lake area, and it is quite possible that greenalite is present elsewhere in the iron formation.

Narrow cross-fibre veinlets of blue asbestos were observed in the iron formation at the Attikamagen deposit of siliceous ore. The fibres are harsh and not easily separable. On the basis of its physical properties, the mineral has been identified as crocidolite. The veinlets are not sufficiently numerous to have commercial value.

Geological work and prospecting during the past field season indicates that there is a band of iron formation within volcanic flows to the east and to the southeast of Astray Lake. D.R.E. Whitmore, who did some geological mapping in the area, describes it as follows: "The iron formation which overlies the agglomerate is very siliceous; the exposed beds are almost entirely banded jasper of different shades of red and grey, containing minor amounts of iron oxides. However, strong local magnetic attraction is present near some of the iron formation outcrops, and magnetite is therefore presumed to be present under the drift. No concentration of iron oxides was seen.

The rock is cut by a well-developed rectangular system of joints. As a result, the surface of most outcrops is covered with loose piles of angular blocks."

Mapping in New Quebec to the northwest of Petitsikapau Lake suggests that there is one and possibly two bands of iron formation within the great slate series. The exact significance of the discovery of these bands is not apparent. The rock is quite manganiferous and in places, concentrations of manganiferous iron ore have been found. The composition indicates that this band (or bands) occurs at a horizon in the series different from the other types mentioned.

The different types of iron formation are readily explained on the basis of one of the theories of origin of iron ore deposits (1) which, in the opinion of the writer, readily explains the facts: the formation is originally deposited as cherty iron carbonate or as greenalite (Mesabi Range). Two processes are then required to bring about concentration. The first is oxidation, in which the carbonate is broken down; the second is leaching by ground water,

(1) Monograph LII, U.S.G.S., pp.529-539.
Prof.Pap. 184, U.S.G.S., pp. 21-24.

which removes the silica. The processes are very gradual and are often arrested, impeded or even hastened by anamorphic and structural changes. Different combinations of these variants produce the several types of iron formation and iron ore deposits that occur.

The following analyses convey some idea as to the composition of the richer parts of the formation. They are classed as siliceous ore:

	I	II	III
Iron	47.06	42.6	48.33
Silica	29.03	33.28	30.03
Phosphorous	0.023	0.03	0.031
Sulphur	0.010	0.02	0.037
Manganese	0.019	0.15	0.092
Alumina	0.80	1.80	- - -
Lime	none	trace	- - -
Magnesia	0.58	1.27	- - -

N.B. All figures based on the natural state.

I - Attikamagen Lake, Labrador.
II - Attikamagen Lake, Labrador.
III - Ridge Lake, Quebec.

(Analysis I by the Steel Company of Canada;
Analyses II and III by J.T. Donald & Co., Montreal, Que.)

Conglomeratic Quartzite

Observations on this rock were made chiefly in the Ruth Lake area. There has been some difference of opinion as to whether or not it should be considered part of the iron formation, because of the high iron content. While admitting this as a possibility, the writer presents conclusions derived from limited observations, which may need revising when further field work is done. There is no doubt,

TIMBER

The vegetation of the central part of the Ungava Peninsula is a continuation of that which covers the mining areas of Northern Quebec. Going north, the trees gradually become smaller and the species fewer. Hardwood is entirely absent in the northern part of the region. The low-lying sections are covered with stunted black spruce which is generally sparse. Occasional stands, however, are of good size. The high hills are destitute of all vegetation except sporadic patches of dwarf birch and a thick coating of caribou moss. Sufficient timber is available to erect buildings and to meet timber requirements in ordinary underground mining.

CLIMATE

The climate of central Ungava is more nearly that of Northwestern Quebec than one would expect. Temperatures descend somewhat earlier in the fall and persist at a low point for a longer period in the spring. The working season is consequently shorter than in Northwestern Quebec. The break-up comes about June 7th to 15th, and the freeze-up about October 15th to 22nd. Usually field work may be carried on from June 15th to October 1st.

The rainfall has not been determined. There are many light showers, few days passing without a sprinkle, but heavy rains are infrequent. In general, it may be said that the flying weather is much more favourable than in Northwestern Quebec.

Weather records, kept at the interior base for two years, indicate that the winter climate is not more severe than that of

Noranda. It is certainly not more rigorous than that of Northern Manitoba, where large mining operations are carried on slightly farther north. It must be borne in mind also that there are successful mining operations in much higher latitudes in Sweden, north of the Arctic Circle, and at Great Bear Lake, which is just south of the Arctic Circle.

INHABITANTS

There are no settlements within the area. Three posts of the Hudson's Bay Company, located on Ashuanipi, Petitsikapau and Michikamau Lakes, were abandoned in 1873.

Robert Ross, fur-buyer of Seven Islands, Que., maintains a post at the head of Ashuanipi Lake during the winter months for trading with the Indians.

Some eighty families of "Mountaineer" (Montagnais) Indians go north up the Moisie River and spend the winter trapping in Labrador and New Quebec. From twenty to thirty trappers from the white settlement at Northwest River also spend part of the winter in the upper Hamilton watershed.

The Indians have been very helpful to the writer since the inception of operations. In fact, they have been the company's best prospectors. Mathiau Andre is the most outstanding. It was he who was attracted by the original outcrop of high-grade iron ore at Sawyer Lake, and to many other metallized localities shown to the writer. Dominique Docteur, beginning in 1936, brought many samples of pyrite and pyrrhotite from the "gossan area" in his trapping ground on the George River. Pierre McKenzie showed the writer two occurrences of iron ore and collected samples of lead, zinc and copper, none of which was of commercial interest.

FISH AND GAME

Game is very scarce in the area examined. The writer is informed that a few caribou migrate south during the winter months. None was observed by any of the parties during the summer. Moose and deer are entirely absent. A few ptarmigan, wild geese and an occasional duck were the only types of game birds observed. Fish are plentiful in the lakes and exceptionally fine trout were caught in great numbers.

Fur-bearing animals are said to be quite abundant. The presence of many trappers in the region bears this out. The writer is informed that some of the choicest pelts come from the interior of Labrador.

PART IV

GENERAL GEOLOGY

GEOLOGICAL SETTING

The Pre-Cambrian rocks of North America occur in the form of a great, shield-shaped area, surrounding Hudson's Bay. The southeastern portion of this area is called the Labrador Peninsula (Ungava).

During late Pre-Cambrian time, a great trough, some 40 miles wide and at least 300 miles long, was formed in the north central part of the Labrador Peninsula. It extends from the upper basin of the Hamilton River, which flows into the Atlantic Ocean, north-west to the Koksoak River, which flows into Ungava Bay. The probable northern extension of the trough has not yet been mapped. The western and southern margins have been partly delineated. Only a small portion of the eastern margin has been mapped.

Within a contiguous area to the northeast, about fifty miles north from the southern margin of the trough, there is a great thickness of lavas of different age from the rocks of the trough proper. Their exact age relationship is unknown, but present evidence suggests that they are older.

Dr. H.C. Cooke (1) has correlated three other troughs with the Labrador trough. They occur in different parts of the "Shield" and are thought to be of the same general age, with somewhat similar lithological characteristics, the most outstanding of which is that ferruginous beds are common to all.

The following is a list of the troughs with their age as given by Cooke:

Penokean Trough (Lake Superior) - M. Hur. - U. Hur.

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(1) Am. Jour. Sci., Vol. 26, 1933, pp.457-474.

Belcher Trough (Nastapoka Series)	- M. Hur.	- U. Hur.
Labrador Trough	- M. Hur.	- U. Hur.
Great Slave Trough	- M. Hur.	- U. Hur.

Low was the discoverer of the large area of sedimentary rocks in Labrador. He considered them to be all of the same general age and to be continuous throughout the trough, although he actually inspected only the northwest and southeast ends of the belt. He mistakenly assigned them to the Cambrian period, but mentioned their strong resemblance to the rocks of the Lake Superior Region, which, at that time, had been mapped as of Lower Cambrian age (1). It is now the consensus of opinion that the Labrador belt is of late Pre-Cambrian age (2).

James and Gill named the assemblage the "Kaniapiskau" series and treated them as a single lithological unit, noting their resemblance to the rocks of "Animikie" (Upper Huronian) age of the Lake Superior District (3).

While concurring in the main with these views, the writer will present stratigraphical evidence suggesting that it may eventually be possible to make certain subdivisions within the initial grouping corresponding more closely with the Lower, Middle and Upper Huronian series of the Lake Superior Region.

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(1) Geo. Survey Can., Ann. Rep. (New Series) Vol. VIII, 1895, p. 262L, pp.265L-266L.

(2) Geology and Economic Minerals of Canada, G.A. Young, Geo. Survey Can., Ec. Geo. Series, No. 1, pp.14-16.

(3) Private report, Drs. W.F. James and J.E. Gill.

RESUME OF MAJOR FEATURES

The rocks of the region are, for the most part, Pre-Cambrian in age. The two great subdivisions of the Pre-Cambrian are represented: the Archaeozoic, consisting of an old series of banded gneisses and crystalline limestone and iron-bearing quartzite (in one part of the region), intruded by anorthosite, anorthositic gabbro and granite. This series is of the "Grenville" type and may be the equivalent of the Grenville series of other parts of the "Shield".

A thick series of volcanic flows with small bands of interbedded sediments occurs in the area adjoining the upper part of the George River. The similarity of these rocks to those of Northern Ontario and Quebec suggests that they are of the same age, and for this reason they are referred to as "Keewatin-type" and hence come under the subdivision "Archaeozoic", although they may eventually prove to be of Keeweenawan age and hence Proterozoic.

The Proterozoic is represented by a group of well-bedded and relatively unaltered sediments - the most abundant types of the Labrador trough - which rest unconformably on the plicated and upturned edges of the ancient gneisses. Thus far, few intrusions have been found within this group. It contains the iron-bearing member which is the object of present economic interest. Extensive bands of intercalated volcanic rocks are also present.

Two comparatively small, isolated areas of sediments occur within the region. They are definitely younger than the ancient gneiss "complex", but their exact relationship to the young group and to each other is unknown. For this reason, the rocks have been given local names and placed tentatively in an intermediate group. One of these areas of sediments occurs to the west of Wabush-Katsao and Shabogamo lakes (Wapussakatoo series). Its particular interest is that it has an iron-bearing quartzite containing up to 50% platy hematite (specularite). Another interesting feature of this series is that it is intruded by a granite batholith (1). The second area of sediments lies between Ossokmanuan Lake and the north end of Gabbro Lake (Ossokmanuan series). Iron formation also occurs in this series. These two areas of sediments are different both lithologically and structurally from the sediments of the Labrador trough proper. In places, also, they are greatly metamorphosed. As this report deals primarily with the geology of the New Quebec Area, these groups of presumably intermediate age are not described in detail herein.

At several localities within the region, there occurs a loosely consolidated, cross-bedded sandstone, which may be of Cambrian age. It greatly resembles the Lake Superior sandstone, which is considered to be of Cambrian age (2).

The region is covered by a thin mantle of unconsolidated material consisting of boulders and sand deposited by the glacier in Pleistocene time.

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(1) Geol. Soc. America, Vol. 48, Pt. 1, 1937, pp.575-577.

(2) Monograph LII, U.S.G.S., p. 109, p.225 et seq.
Prof. pap. 184, U.S.G.S., p. 10.

TABLE OF FORMATIONS (1)

		Thickness in feet
Pleistocene	Boulders, sand.	
	.. Unconformity ..	
Cambrian ?	Sandstone	?
	.. Unconformity ..	
	Gabbro, diabase, diorite, syenite, granite - Regional.	
	Intrusive contact	
Late Pre-Cambrian (Proterozoic, Huronian-type)	(Carbonated rocks	?
	(Volcanics - Regional (2)	?
	(Black and grey slates	2000
	(Conglomeratic quartzite (3)	1000
	(Iron formation (3)	500
	(Brown slate	75
	(Quartzite	400
	(Quartzite breccia	100
	(Dolomitic limestone	500
	(Quartzite - Kivivic Lake	?
	.. Unconformity ..	
	Pre-Huronian (?) - Serpentinite	
	Intrusive contact	
	(Keewatin-type rocks (George River Series) (4) Lava flows, agglomerate, tuffs, small areas of interbedded sediments (Quebec)	?
	.. Unconformity .. (5)	
Early Pre-Cambrian (Archaeozoic)	(Granite, pegmatite, anorthosite, (anorthositic gabbro.	
	Intrusive contact	
	(Grenville-type rocks (gneiss complex)	
	Banded gneisses, crystalline limestone, sedimentary schists.	?

(1) Where not otherwise indicated, the Huronian section is that of Ruth Lake.
(2) Absent from Ruth Lake section.
(3) Probable position of minor unconformity.
(4) May be of Keeweenawan age.
(5) Unconformity known between gneiss complex and Huronian-type rocks.

The geology as given above is based primarily on detailed work on the section exposed in the vicinity of Ruth Lake. The total width of the section is approximately 4,725 feet. The measurements have not been made with precision instruments, but are believed to have a reasonable degree of accuracy with exception of the upper slates, where there may be repetition of beds due to close folding or faulting.

The quartzite breccia is not a separate member of the series, but is simply the lowermost horizon of the quartzite. The bed is so distinctive and of such general occurrence on the west side of the trough that it constitutes an excellent horizon marker, and for this reason is worthy of special mention.

DESCRIPTION OF ROCKS

Ancient Gneisses (Grenville Type)

These rocks have been mapped both to the east and to the west side of the Labrador trough. Their contact with the latter has been traced accurately west of Menihek Lake, and thence northwestward to the height of land. On the east side, it has been traced roughly northeastward from the south end of MacLean Lake across the Ashuanipi River, across Snelgrove Lake, and north from the McKenzie River into the area east of Andre Lake.

The line of contact on the west side is definitely an unconformity, the rocks of the Labrador trough resting on the upturned edge of the gneisses (1). This relationship has been established at

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(1) Geo. Survey Can., Ann. Rep. (New Series), Vol. VIII, 1895, p.262L.

several points. The actual contact has not been observed on the east side of the trough.

The ancient gneisses possess the usual variable character. They range from fine-grained biotite and hornblende-rich types to medium-grained garnetiferous types. Some phases are amphibolitic. The foliation is everywhere distinct and banding commonly present, the nature of the bands varying with the type of mineral that preponderates. Lit-par-lit injection also causes banding. The constituent minerals are: biotite, hornblende, quartz, orthoclase, albite and garnet.

Migmatites have also been observed.

Both paragneiss and orthogneiss occur, but their distribution is erratic. The orthogneiss is slightly coarser-grained. It occurs in sheets or elongated lenses, paralleling the foliation of the paragneiss. Pegmatitic phases of the orthogneiss are common.

Preliminary mapping indicates that a band of sedimentary schists occurs along the margin of the gneiss complex to the east of the area underlain by Huronian-type rocks and Keewatin-type rocks.

Crystalline limestone has been observed at several localities, but it is particularly abundant in the southwest part of the Labrador concession.

The trend of the ancient gneisses is quite variable.

Intrusives in the Ancient Gneisses

Several small stocks of granite and one small stock of hornblende syenite cut the gneisses.

Large areas of granite and paragneiss, which occur at the headwaters of the Woods River have not been differentiated on the accompanying map. The area surrounding Lobstick Lake is also underlain by a complex consisting of granite, syenite and sedimentary gneiss.

The granite rocks are probably of the same age as the granite first examined by Low (1) at the southwest end of Michikamau Lake, and re-examined by the writer. Two 20-foot diabase dykes were observed cutting the granite. Pegmatites, although observed, are of rare occurrence.

Only one small area of anorthosite was observed in the parts that have been mapped. Low mentions large areas occurring to the northeast.

Altered pyroxenite was observed on a reconnaissance traverse on the Milner River, west of Menihek Lake.

Anorthositic gabbro is the predominant intrusive both in the south and southwest parts of the Labrador concession. The rock is very massive and resistant to erosion. It stands out as prominent rounded hills. There is considerable variation in composition within the different masses. The different types have been grouped together for convenience of treatment.

Keewatin-type Rocks (George River Series), by A.T. Griffis

In the eastern part of the New Quebec Area, and lying to the northeast of the Huronian trough, there is an extensive area underlain by rocks which are predominantly of volcanic origin.

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(1) Geo. Surv. Can., Ann. Rep. (New Series) Vol. VIII, 1895, pp. 229L-230L.

however, as to its fragmental character and its position in the section. It overlies the iron formation.

The rock is characterized by marked heterogeneity both in colour and appearance. Usually the most abundant mineral present is quartz, which forms the matrix. Angular and subangular fragments, consisting of hematite, chert and jasper, are embedded in the quartz. They vary in size from small equi-granular particles about the size of a pinhead to large fragments from two to three inches across. The rock is usually quite magnetic. In places, it is more properly a grit than a conglomerate, and in the upper horizons, the fragmental character of the rock is apparent only on close examination. Iron is generally present in the hand specimen. At one locality, the rock was a cherty oolite with no reddish oxide of iron visible.

The colour likewise changes considerably. It goes from greyish, through pink to red, to brown or even yellowish-brown, the latter probably due to the hydration of the hematite. The hematite content is sometimes so high that this iron-rich quartzite may be mistaken for iron formation. In early work in the area this often occurred, but it was later discovered that the fragmental character and the absence of banding are excellent means of differentiating between this rock and the iron formation. In Michigan, a bed of similar character (examined by the writer during a visit there) was sufficiently rich in iron at one point to be mined.

Black and Grey Slates

Two large areas are underlain by slates. One extends northwest along the Menihek Valley to Kivivic Lake and beyond. The second underlies Petitsikapau Lake and extends north along the headwaters of the Swampy Bay River. A narrow band is present also along the east side of Dyke Lake. It is difficult to arrive at an exact figure regarding the thickness of the slates and their regional position, because they are the incompetent member of the series, and in consequence are probably repeated by faulting or close folding.

The term "slate" as used here is very general and includes some shales. The usage is similar to that of the Lake Superior Region.

The slates are the usual, fine-grained, fissile types, having, in places, a well developed slatey cleavage. The common variety is black and carbonaceous. Grey laminae, which are probably calcareous, also occur, and uniformly grey varieties have been observed. These types are comparatively soft, but at a few localities, harder, siliceous types also occur. Black limestone, within the shaley types, has been mapped on Petitsikapau Lake, and a bed of cobbles, composed of the same material, is also present. The latter is probably an intraformational conglomerate, but it may represent a minor disconformity within the slate series. The black limestone appears to occur as lenses within the shales. Mapping done to the northwest, in Quebec, during the past summer disclosed that the limestones occur as lenses there.

Chloritization on a small scale has taken place in the vicinity of two intrusive sheets on Knob Lake, where the slates are green.

Red varieties have been reported, in which the colour is probably due to a high iron content. Ribbon-banded types have also been observed, the alternating laminae consisting of fine greenish-grey layers lined with reddish cherty layers.

These slates resemble the great slate series - the Upper Huronian - of the Lake Superior Region (1).

Volcanics

Extensive areas within the region are underlain by volcanic rocks, as shown on the accompanying map. They outcrop on the east side of Astray Lake and continue intermittently within the area included between Astray Lake on the west and Andre Lake on the east. They were observed as far south as the west side of Sims Lake. Many of the high hills east of Dyke Lake are composed of volcanic rocks. They are absent from the Ruth Lake section.

The flows are, for the most part, andesitic in composition. One band of rhyolite was observed to the north of Stewart Lake. The andesites are usually altered, few specimens being fresh when examined in thin section.

Pillow and amygdaloidal structures often occur in these rocks. Flow breccias were observed at several points. Tuffaceous beds are also present. Some are quite magnetic. One interesting feature is the presence of narrow beds of angular and subangular fragments of ferruginous chert similar to the material of the cherty beds in the iron formation, which suggests that both may be of kindred origin.

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(1) Lake Superior Iron Ores, 1938, p.51.

Some flows are different in character from the usual volcanics. On Red Mountain (west of Dyke Lake), there is a brownish rock, with a greasy lustre and porphyritic texture. The matrix is almost glassy, and the phenocrysts, making up only a small fraction of the rock, are of grey feldspar.

On the ridge between the two southernmost arms of the northeast end of Petitsikapau Lake, there are some elongated hills composed of fine-grained grey rock that weathers to a dull brown. It is lighter in colour, coarser in grain, and more massive than the typical andesite. It is probably a trachyte or dacite.

On this same ridge, there is a peculiar rock associated with andesite at several points. The late Dr. B.C. Freeman (1937) termed it a "cherty, magnetic tuff". It is an agglomerate composed of chert, chalcedony, magnetite in radial, flattened fragments, and jasper in a chloritic matrix, the whole interbedded with chlorite schist. At one locality, the fragments are separated by a hard, dark green, granular material which may be a true water-laid sediment or a siliceous ash. This unique rock may have been formed by the metamorphism of ash beds.

Another unique type was observed by the writer to the west of Dyke Lake. It consists of brecciated blocks of ferruginous chert up to ten feet long and one foot across, embedded in a typically andesitic rock. These blocks probably represent the remnants of a chert bed which has been crushed in the vicinity of one of the big thrust faults that exist within the region.

The stratigraphical position and the time significance of the volcanics is not fully known. The different bands may represent rocks of different age. The absence of volcanics from the Ruth Lake section and from the northwest part of the map-sheet indicates that they lens out to the northwest. To the north of Snelgrove Lake, A.E. Moss mapped a volcanic member directly above the iron formation. He also found two other volcanic members lower in the section. Isolated outcrops were mapped by A.T. Griffis on Attikamagen Lake. It is thus apparent that additional work will be required before complete details on the volcanics can be given.

Carbonated Rocks

Dr. A.E. Moss (1942) mapped a relatively small area of greatly altered rocks in the vicinity of Marion Lake, which he describes as follows:

"There are present within the Huronian-type area several outcrops rich in carbonate. Some of these rocks are very similar to the dolomite rocks found in many parts of Northern Ontario and Quebec. They are brown-weathering, medium to coarse-grained and massive, consisting essentially of dolomite with minor amounts of chloritic material. They are frequently cut by a stockwork of narrow quartz veins containing coarse, disseminated pyrite. Portions of the rock may be extremely chloritic.

Within these carbonated types there are sometimes present less altered portions, in which sedimentary structures can be recognized. Remnants of conglomerates, coarse-grained quartzites and shaly beds have also been observed.

These highly carbonated zones are believed to be the result of intense hydrothermal alteration. The hydrothermal solutions penetrated the more porous or fractured rocks, which accounts for their erratic distribution. The writer has made no attempt to interpret their boundaries."

Woollett Lake - Kawachik Lake Area, by D.R.E. Whitmore

During the past season, D.R.E. Whitmore mapped a rectangular area roughly 18 miles long and 4 miles wide, beginning at Petitsikapau Lake and continuing northwest through Kawachik and Woollett lakes. The rock assemblage is different from that found to the southwest, and for this reason, Whitmore's complete description is given.

"The area lies on the southwest limb of a syncline which trends northwest. The structure is further complicated by at least four major drag folds, innumerable minor ones, and several strike faults. Although outcrops are comparatively abundant, they are insuffcent in many places to enable the structure to be worked out in detail.

Table of Formations:

	Thickness in feet
Quartzose, greywacke and slate	2000
Grey shale	
Black shale	
Magnetite stilpnomelane rock	
Iron formation, jaspilite	200-400
Impure thin bedded quartzite	
"Slaggy weathering" rock	200
Black shale	
Pure and arkosic quartzite	100-200
Red and cream-coloured shale	500
Black thin-leaved shale	100-300
Interbedded dolomite and grey shale	

Dolomite and grey shale:

The lowest rocks exposed are grey to grey-green shales, in part converted to slate. They seem calcareous, and in a few places are cut by narrow veins of ankerite. They are exposed here and there along the west shore of Squaw Lake and in the area between Squaw, Woollett, and Key lakes.

The dolomite occurs at several horizons within the shales as bands ten to forty feet thick. It is more abundant towards the top of the sequence. The best exposures are on the shores of John and Limestone lakes. Scattered outcrops are found also along the west shores of Squaw and Woollett lakes, and at the north end of Squaw Lake. An isolated outcrop occurs about 1000 feet southeast of the southeast bay of Squaw Lake.

Some of the dolomites are slightly ferruginous. They are fine-grained, so little recrystallized that they are almost Paleozoic in their appearance. They are dark grey to almost black on the fresh surface and weather to a pale blue-grey or cream colour. They are fairly pure, the main impurities being silica in the form of both clastic quartz grains and chalcedony nodules, pyrite as occasional blind streaks and nodules, and fine black dusty material probably carbonaceous in nature. They are well-bedded, with individual beds ranging from one foot or more in thickness down to paper-thin laminae. The amount of carbonaceous matter or of quartz grains differs from bed to bed. Occasionally the latter are sufficiently abundant to form thin beds of quartzite. There is little tendency for the rock to break along the bedding planes and consequently it is comparatively massive and resistant to mechanical weathering.

The weathered surface, however, shows the effect of solution, a characteristic result of which is the production of smooth round solution pits like thumbprints.

Ellipsoidal black chert nodules are very abundant in some beds, where they appear to be concentrated near the bedding planes.

Intercalated with the normal limestone are many beds of intraformational conglomerate - angular limestone fragments of all sizes embedded in a slightly darker, more ferruginous, limestone matrix. In places, chert nodules, fragments of chert nodules, chert sand and also limestone sand are abundant. The finer parts of the breccia often show cross-bedding and channel scour. A single bed of such breccia is exposed along most of the western shore of John Lake.

Almost everywhere thin veinlets of white quartz and ferruginous dolomite cut the limestone at right angles to the bedding.

Black shale:

Intercalated with the uppermost limestones and overlying them is a black shale. Most of it is in paper-thin laminae which readily weather apart, reducing the outcrops to a smooth heap of rubble, which from a distance appears like piles of coal. More massive outcrops with beds up to six inches or more in thickness are less abundant. In part, at least, the shale owes its colour to very finely divided pyrite, which is everywhere present locally, aggregated into nodules and streaks one-quarter inch in diameter. Streams flowing across the shale may become charged with iron from the weathering of the pyrite. One such small stream flowing north into the southeast bay of Squaw Lake has laid down in its bed a finely-laminated deposit of limonite two to three feet thick.

In part also, the colour of the shale is due to carbonaceous material. In one outcrop at the north end of John Lake, the shale is cut by innumerable small glistening graphitic slip planes.

Small chert nodules, and a few thin chert beds occur at certain horizons in the shale.

Red and Cream-coloured shales:

Overlying the black shales is a considerable thickness of cream-coloured and red shales, up to 500 feet. The transition is quite abrupt. They outcrop almost continuously along a zone which extends from a point about half a mile east of the south end of John Lake to the south end of Woollett Lake. They vary conspicuously from the western flank of a ridge underlain by iron formation, and in a few places, notably east of John Lake, they actually stand above the iron formation, occupying the summit themselves. Other outcrops, a result of repetition by faulting, extend from the east shore of John Lake to the south shore of Squaw Lake. At several places east of Woollett Lake they are brought to the surface by folding.

The individual laminae of the shales are fairly uniform in thickness, varying from one-quarter inch to one inch. The colour varies from a creamy yellow to red and brownish-red. The red colouring appears to be secondary, and due to introduced hematite, for it spreads into the shale from the bedding planes and cross joints. East of John Lake, where a rude fracture cleavage has developed, the red coloration also spreads in from them.

Pure and Arkosic Quartzite:

The quartzite overlies the red shale usually directly, although in some places it is separated from it by a thin bed of greenish argillite. It is a white weathering rock, and occurs in beds about one foot thick, separated by paper-thin laminae of black carbonaceous (?) material. In some beds similar black material occurs as small knots throughout the rock. In many places cross-bedding and channel scour indicate deposition in shallow water and, incidentally, make the determination of attitudes possible.

The quartzite is somewhat variable in grain size and in the composition of both the grains and the matrix. In general, it is a fairly pure quartzite of medium grain, becoming coarser and more arkosic in the top twenty feet. The quartz grains are well rounded, and show secondary growth. The outline of the original quartz grain is often marked by a thin, dusty film of hematite, and hematite is often abundant in the quartz cement. Where this is the case the rock tends to weather pink, and is bright red on the fresh surface. Clastic grains of microcline, although not abundant, are fairly common. Particularly in the arkosic top portion they tend to be angular - almost like fresh crystals broken from a porphyry. Their shape is somewhat anomalous and hard to explain. A few rounded grains of chalcedony make up the rest of the rock.

The upper surface of the quartzite is in some places (east of Woollett Lake) coated by a thin layer of black chert which penetrates cracks in the quartzite and occasionally completely surrounds small angular fragments.

Small outcrops of similar quartzite were seen on a traverse to Petitsikapau Lake. Neither red shales nearby, nor any contact were observed, so whether it is the same as that occurring in the vicinity of Squaw and Woollett lakes, it was not possible to determine.

Black shales, etc.:

At the top of the quartzite an abrupt transition takes place into the overlying black shales. The shales are almost identical lithologically with those mentioned previously. They occur, however, in thicker laminae. Certain beds are very rich in pyrite, apparently a feature of initial deposition, or at most diagenetic.

Between the shales and the iron formation is a nondescript assemblage of rocks. One, termed the "slaggy weathering rock", is in places exposed directly above the black shales. It is a dark brown to green, fine-grained, soft rock, not noticeably bedded. It is cut by innumerable small fractures, which cause the outcrops to weather into piles of small, pea-like fragments, somewhat resembling slag that has been run into water.

Underlying the iron formation are various thin lenses of medium and coarse-grained impure arkosic or greywacke-like sediments. None of these lithologic units is at all persistent along the strike. Although most of these rocks contain a little magnetite and some contain a considerable amount, the main persistent magnetite-rich horizon lies above the iron formation.

Iron Formation:

Usually, though not invariably, the iron formation is found underlying the high ground in the area. Thus the crest of the ridge extending from a point east of the south end of John Lake to Woollett Lake coincides, more or less, with a discontinuous outcrop of iron formation. To the east of this main exposure, drag folding brings the iron formation to the surface in many places, the most easterly of those observed being one-quarter mile west of the south end of Kawachik Lake. Most of the drag folds have the western limbs steeper than the eastern, and the crests may be quite sharp. The axes of the drag folds plunge gently northwest and southeast, giving an elongated elliptical shape to the iron formation outcrop. Short tensional veins of white quartz cut perpendicular to the strike of the iron formation at the crests of some of the folds. The iron formation varies from less than 200 feet to about 400 feet in thickness. A deep gully east of Woollett Lake cuts through over 1000 feet of iron formation. Repetition by folding or faulting or both seems likely here, but was not established.

The outcrops are characteristically covered by an aggregation of roughly rectangular blocks - the result of ready fracture of the iron formation along the bedding planes and a rectangular system of joints. Occasionally, particularly where the joint planes are very close together, the outcrops are simply heaps of rubble with no material in place. However, where the jointing is not so well developed the outcrops are quite solid and form low hogback ridges with long dip slopes.

The iron formation is somewhat variable in its characteristics. There are three main types: coarse, banded jasper and iron oxides and associated breccias; slaty-appearing types; fine-banded, white or grey chert, and iron oxides. The first two types comprise over 90% of the outcrops, with the first predominating over the second.

The first type consists of alternating bands of red jasper (less commonly, grey or black chert) and a mixture of chert and iron oxides (hematite and magnetite). The bands vary up to three inches, averaging less than an inch. None of them is persistent for more than 20 feet along the strike. The rock then has the structure of a series of thin interfingered lenses. Occasionally within the iron oxide rich portions are aggregates of concentrically-banded nodules, consisting of alternating red and white chert layers. The jasper itself, when examined microscopically, may be seen to be made up of small grains of chalcedony, dusty with hematite and embedded in a matrix of clear chalcedony. A few of these granules are concentrically banded. Carbonate as small euhedral grains is present in the jasper, but is not abundant.

Breccias are numerous in the jasper iron formation as conformable beds overlain and underlain by unbrecciated material - intraformational conglomerates. In fact, much of the normal iron formation is a microbreccia. Many of the chalcedony granules in the jasper have clastic outlines. Fragments in the breccia beds are angular and tabular pieces of jasper, etc., embedded in a finer matrix of similar composition. Almost universally the fragments show an enrichment in iron oxides about their peripheries, and the matrix material is also richer in iron. On a microscopic scale the same phenomenon is shown round the borders of some of the chalcedony granules in the jasper. At certain horizons, rounded clastic sand grains of clear quartz are common, though not abundant.

The "slaty" types of iron formation are so called not because of the presence in them of the minerals characteristic of slates but because of their slaty fracture. They are dull red rocks made up of hematite and silica and usually somewhat porous. The silica is not generally visible in the hand specimen. Under the microscope collapsed residual oolitic structures can sometimes be made out, suggesting that this rock is a phase of the ordinary jasper iron formation enriched in silica - in a manner similar, in fact, to the peripheral enrichment of jasper fragments in the breccia. In a few places this enrichment has given streaks and thin beds of ore and near-ore. The enrichment from its relationships and distribution in the breccia is probably to be considered diagenetic.

Very minor in amount are beds of white chert, or white chert alternating with thin laminae of hematite and magnetite.

At many places there is evidence of considerable migration of iron, and, to a lesser extent, of silica. Limonite replaces some layers of white chert along both the bedding and joint planes.

Greenalite was nowhere observed in the iron formation. A greenish mineral is found almost everywhere as pale pleochroic needles replacing chalcedony. Where it occurs in abundance the iron oxide is usually magnetite, and indicates that it may be a product of low-grade metamorphism. Where more coarsely crystallized, the mineral is brown and has properties similar to those of biotite. Its birefringence is greater than that of biotite, however, and it is probably stilpnomelane.

At one place on the south shore of Squaw Lake a limonite-rich, and apparently manganese-bearing, quartzite appears. The quartzite is extremely fine-grained and cherty in appearance, and in the notes has been termed as iron formation. It appears to be true quartzite, however. At the water's edge it is much fractured and in the fractures limonite and pyrolusite have accumulated as botryoidal and stalactitic growths. Some such masses weigh up to two pounds.

Magnetite Stilpnomelane Rock:

A dark brown to green rock, consisting of magnetite, chert and a platy mineral resembling stilpnomelane overlies the iron formation, underlying it also in a few places. As it is strongly magnetic, it is useless to attempt to use a compass in its vicinty. It has blocky weathering, very similar to that of the iron formation, and many of its internal structures, particularly in its lower parts, are similar to those of the breccia bands in that rock. The upper part consists of alternating brown magnetite rich layers and white cherty layers. Altogether it looks like slightly metamorphosed iron formation.

Black and grey shales:

These shales, which overlie the magnetite rock, are very similar lithologically to those lower in the sequence already described. Associated with the black shales there are in some places east of Woollett Lake also brown limonite-rich shales. The grey shales to the east towards Kawachik Lake tend to develop a slaty cleavage.

Quartzose greywacke and slates:

The youngest sedimentary rocks mapped underlie the lowland which extends east from Gunshot, Kawachik and Hanas lakes beyond the area examined. The thickness exposed in this area is probably at least 2000 feet. The total thickness is unknown.

They comprise a series of interbedded, dark grey to black quartzose greywackes, and grey, slaty shales. The greywackes are well exposed along the eastern shore of Gunshot Lake and the western shore of Kawachik Lake. Outcrops of the slates, less numerous, are found east of Kawachik and Nameless lakes. The greywackes are dark, medium-grained, homogeneous rocks, in thick, poorly defined beds. On the fresh surface numerous dark, glassy quartz grains appear. Under the microscope the rocks are seen to be composed chiefly of angular, clastic grains of quartz and plagioclase, with lesser amounts of mafic minerals such as hornblende and chlorite. A fine chlorite matrix surrounds the grains. A well developed system of joints causes the rock to break into almost perfect rhombohedrons. In most places the greywacke is undeformed, and in only a few places, on the shore of the east bay of Kawachik Lake, has a faint schistosity developed. On the east shore of Gunshot Lake the surface of the greywacke outcrops is pitted by smooth holes about the size and shape of golf balls, probably representing former concretions of softer material such as carbonate. The slates are very similar lithologically to the greywacke but are finer grained, and, of course, much more schistose. Ellipsoidal, concentrically-banded chert concretions, about the size of eggs, and containing pyrite, occur in the slates east of Nameless Lake."

Intrusives (1)

Some of the intrusives cut only the rocks of the Labrador trough. Others of the same and other types are found within rocks of presumably intermediate age. Others cut Keewatin-type rocks. Those which are found in the ancient gneisses and the pre-Huronian serpentinite have already been mentioned.

Gabbro

Gabbro occurs southwest of Dentist Lake, on the east side of Birch Lake, on the east side of Sawyer Lake, on the ridge between Petitsikapau and Attikamagen lakes, on the south end of Wet Lake and on Knob Lake. It occurs in masses of irregular outline, as dykes, sheets and/or sills. At some localities, the rock is fresh, while at others, it is altered. The feldspars are saussuritized and the pyroxenes have gone over to hornblende and chlorite. Ophitic texture is occasionally present.

Diabase

A very fresh olivine diabase cuts the slates and greywackes on the east shore of the east bay of Kawachik Lake. From the areal relations of the outcrops, the rock either forms a sill or a dyke

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(1) Regional types are described.

cutting the sediments at a low angle. The rock is dark grey on the fresh surface with shiny black pyroxenes (pigeonite and augite) and clear glassy feldspars (calcic andesine). Olivine, which forms about 10% of the volume of the rock, is very fresh. Nowhere does it show any alteration to serpentine, etc. The rock weathers brown.

Similar sills or low-angle dykes cut the quartzites on the south shore of Squaw Lake and the limestones on the east shore of Limestone Lake. In neither case were contacts observed. These dykes are somewhat more altered in appearance and have a slight greenish colour.

Isolated outcrops of diabase were found on the traverse to Petitsikapau Lake. In one outcrop about three miles south of John Lake an amygdaloidal andesite cuts quartzite and black shales. The rock is fine-grained, porphyritic and considerably altered. Phenocrysts are of plagioclase and pyroxene, both indeterminate. The amygdules are calcite-filled and occur in layers parallel to the contact. The rock greatly resembles a flow, but its relations to the surrounding rocks appear to be intrusive. Probably it was intruded at a shallow depth.

Small sheets of diabase have also been found on the east side of Knob Lake.

Gabbro-diorite Complex

Beginning at the south end of Andre Lake and extending northwestward for a distance of approximately fifty miles is a large dyke, roughly one mile across. At the northern end, the known exposures suggest that the width is considerably greater. A number of sills also occur to the east of Cunningham Lake. Detailed work has not been done on any of these masses, but from limited observations it appears that there is considerable variation in different parts. The rocks range from greyish, largely feldspathic types, through diorite and gabbro to pyroxenite. This would seem to indicate that considerable differentiation has taken place.

Diorite

Diorite occurs as a small mass at the southeast end of Dentist Lake. It also occurs in sheets and small stocks along the east side of Dyke Lake from the south to the north end. A large sheet is present along the northwest part of Attikamagen Lake. The trend is northwest. It is the usual, medium-grained, light-coloured type with the feldspar and hornblende observable in the hand specimen. Microscopic examination reveals that it is composed of andesine and hornblende, with the latter altered in places to chlorite.

Syenite

Several small and narrow sheets of pink syenite occur on Wet Lake. They strike north-northwest. They have been sheared and altered, the mafic minerals having gone over to chlorite. Inclusions of quartzite are also present.

Granite

Two small stocks of pink granite occur to the west of MacLean Lake. The rock is poor in ferromagnesian minerals. It is more properly an alaskite than a granite.

There is a large area of granite at the south end of Michikamau Lake, originally mapped by Low (1). Its age relationships are unknown.

Feldspar Porphyries

Three types of feldspar porphyry have been found. Two occur as sheets. One is dioritic in composition, with white feldspars up to one-half inch across, embedded in a fine-grained, greenish ground mass. Only one outcrop of the second type was observed. It is a slightly pinkish, medium grey, porphyritic rock. The phenocrysts are red to grey tabular crystals up to three-eighths inch long and are probably orthoclase. Irregularly lenticular and rounded masses of chlorite and of quartz aggregates are also present. Pyrite is present in rounded blebs, cubes and films along the joints.

The third type occurs on the ridge east of Marten Lake, along the Quebec-Newfoundland boundary. It outcrops for a distance of two miles and is roughly 2,000 feet wide. The strike is northwest. A.T. Griffis, who did the mapping at this locality, very properly calls it a "felsite porphyry" and describes it as follows: "It is a red-weathering, bright-red, felsitic type with distinct phenocrysts of pink-orange feldspar. It is massive throughout, shows no flow structure, and may be extrusive or intrusive."

Cambrian (?)

Sandstone

One outcrop of sandstone was observed at the base of the cliff along which the Ruth Lake deposit of iron ore occurs. It is the highest member of the section. The rock is reddish, fine-grained,

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(1) Geo. Survey Can., Ann. Rep. (New Series) Vol. VIII, 1895, p. 282L.

loosely coherent and markedly cross-bedded. So far as could be ascertained in a very rapid examination, it is flat-lying and rests unconformably on the members of the older series.

Flat-lying sandstone has been mapped on the east side of Sims Lake. Sandstone has also been observed on the western edge of the high hills west of Sims Lake, but its attitude is unknown. It is quite probable that this sandstone is all of the same age.

Sandstone, of Lower Cambrian age, occurs on the north side of the Strait of Belle Isle (1). Along Hamilton Inlet and along the "Double Mer" to the north, close to the Labrador coast, sandstone of probable Cambrian age was mapped by Kindle (2). It seems more than a coincidence that a sandstone of general occurrence is found in the Lake Superior Region (Lake Superior sandstone) which is also considered to be probably of Cambrian age (3).

STRUCTURE

The prospect of unravelling the intricacies of complex structure is slight and unsatisfactory in an area in which field work has been confined largely to reconnaissance mapping. The problem is further complicated by the incomplete data on the geologic succession. However, certain broad structural features have emerged from the work, and on the basis of these, a tentative interpretation of the structure of the area has been made and is submitted on the accompanying map.

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(1) Logan, Wm.Sir, Geology of Can., 1863, pp.865-867.
(2) Kindle, E.M., Mem. 141, Geo. Surv. Can., pp. 56-58.
(3) Monograph LII, U.S.G.S. p. 109.

Grenville-type Rocks

The ancient gneisses of Grenville type possess the usual plicated and contorted structures. No attempt has been made to work out these structures, and, until detailed mapping is done, the regional trends must remain unknown.

On the margin of the gneisses along the west branch of the George River in New Quebec, the rocks are strongly sheared and dip steeply to the northeast. These features suggest that the gneisses have been thrust above the volcanics. Locally, along Shabogamo Lake in the southwest part of the Ossokmanuan Lake Sheet thrusting of the gneisses above the Wapussakatoo series also seems to have occurred.

Keewatin-type Rocks (George River Series), by A.T. Griffis

"Much of the area mapped by the writer in 1942 is underlain by the George River volcanics, and the following remarks are chiefly concerned with these rocks.

As pointed out earlier in this report, the volcanics are made up of a series of greenstones, pillow lavas and some associated interflow sediments. The series faces east throughout most of the area and regional structure is essentially monoclinal.

The contact of the lavas with the Huronian (?) sediments has not been observed and is obscured in part by the sills of diorite that occur both in the sediments and the lavas from the west side of Lake Attikamagen as far east as McNeill Lake. On the east, the lavas are cut off by a granite and paragneiss complex which strikes north-south and crosses the George River about three miles west of the point where the river swings to the north.

This is a fault contact, as paragneiss is the first rock encountered east of the volcanics, and these rocks have moved upward many thousands of feet. The result of this movement has been to cut off the northeasterly facing lavas along a north-south line, thus forming the "wedge" of lavas between the Huronian (?) sediments and the granite-gneiss complex.

The relatively simple monoclinal structure in the lavas is interrupted in places by steeply-pitching drag-folds in which the northeast side has moved southeasterly with respect to the northwest side. Three such folds were noted, and many others probably occur. The largest one is at Doublet Lake, where the rocks have been folded across a width of at least three miles and the total movement may have been more than two miles along the strike of the formations. This fold appears to pitch southeast at 60° and suggests an upward movement on the east side. This drag-folding may have taken place at the same time as the folding and faulting of the Huronian (?) sediments to the west, since both deformations were brought about by similar forces operating from about the same direction.

The granite-gneiss complex was not mapped over a large area, and outcrops are rather scarce. Nevertheless, some features of importance were noted. The most westerly rocks of the complex are sheared, metamorphosed, well-bedded sediments and appear to face east. These show a north-south trend and vertical or steeply east dips. Eastward from these sediments the rocks become more highly sheared and altered and are essentially quartz-biotite-muscovite schists. Granite, granite-gneiss and injection gneiss outcrop some five miles east of the lava-gneiss contact, and it is probable that the lava-gneiss and granite-gneiss contacts are parallel. Throughout this area, the trend of the schistosity is north or northeasterly, which is sharply divergent from the trend of the Huronian (?) rocks and the George River Series. One effect of this is that the width of the George River Series rapidly increases to the north. The significance of this truncation of the lavas by the granite is not yet evident, but may have been brought about at the time of the post-Huronian (?) folding and faulting."

Huronian-type Rocks

More mapping (although it is generally reconnaissance) has been done on the Huronian-type rocks than on those of Grenville-type or of Keewatin-type. This work has disclosed that the Huronian-type rocks form a great geosyncline which has in places been folded and faulted.

Examination of the accompanying map reveals that the dominant structures strike north-northwest, parallel to the trend of the Labrador trough. The maximum stress clearly came from the northeast. The major folds are asymmetrical with axial planes dipping northeast. The major fault surfaces dip similarly, the east side being thrown up. In addition, there are less prominent cross-folds (drag folds and buckles) at various angles to the major trends and small cross faults are also present. Folding and possibly faulting has been of prime importance in the concentration of iron ore.

Prominent large drag folds were observed from the air, close to Attikamagen Lake, west of Dyke Lake and to the West of Cunningham

Lake. There is a major cross structure which trends north-northeast from Point Lake to Montgomery Lake, a distance of 24 miles. It is a conspicuous topographic feature of this part of the region. There are many buckles across this structure, which stand out prominently in flying over the area. The Sawyer Lake deposit of iron ore occurs along this structure.

In the Ruth Lake area, the strike of the rocks conforms to the regional trend: it is north-northwest. Two major thrust faults have been traced continuously through the section mapped. One has been called the "Slimy Lake Fault"; the other, the "Knob Lake Fault". Both are roughly parallel and follow along depressions. The Slimy Lake fault is marked by a very prominent escarpment which runs along the valley to the east side of Slimy Lake. The beds are thrown up on the east side of the fault. On the west side, there is a big drag fold that has been traced upwards of one-half mile. The Ruth Lake iron deposit is situated within this drag.

The trace of the Knob Lake fault follows along the eastern margin of the ridge that runs from Knob Lake northwest to Ridge Lake. The east side of the fault is again thrust up.

Minor slicing is also present in the area as two smaller thrusts occur; one is located about halfway between the two major faults, and a smaller one to the east of the Knob Lake fault.

All these faults strike north-northwest. Small folds with axial planes striking similarly also occur. Drag folds are believed to exist at Denault Lake, though the presence of drift renders this uncertain. Another drag fold was observed at Burnt Creek.

Small cross faults striking northeast are also present.

CORRELATION AND MUTUAL AGE RELATIONS

Long-distance correlation between areas of Precambrian rocks is at best difficult and doubtful. However, it is of interest to point out some of the outstanding features of similarity between Labrador and other regions.

Grenville-type Area

There is present generally an area of gneisses with small amounts of crystalline limestone and sedimentary schists, cut in places by granite, which greatly resemble other areas underlain by Grenville rocks in Ontario and Quebec. For this reason, these rocks are referred to as "Grenville-type". They are the oldest rocks of the area.

Keewatin-type Area, with Discussion by A.T. Griffis

Probably above the Grenville-type area and separated from it by a thrust fault is an area underlain by a thick series of volcanic flows which greatly resembles Keewatin-type rocks of Ontario and Quebec. They may also be of Keeweenawan age, but the fact that they are cut by intrusives (serpentinite) which do not cut the younger series (Huronian-type rocks) suggests that they are older than this younger series and hence are referred to as "Keewatin-type".

Dr. A.T. Griffis, who mapped the geology of the upper part of the George River (west branch), has contributed the following discussion on the age of the George River Series:

"The evidence in regard to the age of this lava series will be briefly outlined. The lavas are similar in appearance to the Keewatin lavas of Ontario and Quebec. They are chiefly of andesitic composition and show pillowed and massive flow types. They appear to be, on the whole, more highly altered than the Huronian-type sediments to the west. In addition to these features, they are intruded by sills or dykes of serpentinite that have not been found intruding the sedimentary series. This serpentinite is identical in appearance to Algoman serpentine rocks in Northern Ontario and Quebec, which are definitely post-Keewatin and pre-Huronian. Furthermore, the contact of the Huronian-type sediments and lavas is evidently one along which much faulting and drag-folding has occurred. The available evidence suggests that the Huronian (?) sediments have been cut by a series of easterly dipping thrust faults, and that the lavas have been thrust against the sediments. For these reasons, then, the George River Series is considered to be of Keewatin age.

There is some evidence against this correlation, however. The first point is that the diorite, which intrudes the Huronian (?) sediments and occurs as sill-like bodies within the lavas, is very similar in appearance and composition to coarser facies of the lava flows. A second point is that the diorite is often found closely associated with the inter-flow tuffs of the George River Series. This could mean that the "diorite" was extruded in thick sheets, and that tuff was laid down during inter-flow periods. It may only mean, however, that the diorite was intruded along the relatively weak tuff horizons. In addition to these points, the attitude of the sediments and lavas, without considering folding or faulting, is more or less a continuous succession from northeasterly-dipping and facing sediments on the west into lavas on the east. Moreover, the lava series does not appear to contain small intrusive bodies of acid rock types, such as are common i areas of Keewatin rocks, in the vicinity of Algoman granites.

The available evidence could lead to the conclusion, on the one hand, that the lavas should be correlated with the Keewatin series, or, on the other, that they are of Keeweenawan age. On the basis of present knowledge, the more reasonable conclusion is that they are of probable Keewatin age, and have been brought into their present position against the sediments as the result of folding and faulting."

Huronian-type Area

These rocks rest unconformably upon the ancient gneiss complex (Grenville type) on the western part of the Labrador trough. The relationship on the east has not been definitely established.

They greatly resemble the Huronian rocks of other areas and for this reason are thought to represent the same general period of Pre-Cambrian deposition and are hence referred to as "Huronian-type".

Geological Resemblance of Huronian-type Area to Lake Superior District

There is a remarkable similarity between the geology of the Labrador trough and that of the Lake Superior District. The work of

Low in 1893-94, that of James and Gill in 1929, and that of the writer, with his assistants, during five field seasons, has demonstrated repeatedly the extraordinary resemblance between the rocks of each district. Moreover, the views presented herein are confirmed by personal observation, as the writer, through the courtesy of Pickands, Mather and Company, of Cleveland, was privileged to visit each of the iron ranges of the Lake Superior Region.

The following tables show the section of the Marquette Range, Lake Superior District, together with that which occurs in Labrador (1).

		Marquette	Ruth Lake, Labrador
Cambrian - Upper Cambrian Sandstone			Sandstone
Unconformity			Unconformity ?
Algonkian			
Keeweenawan - Intrusives			Intrusives
Intrusive contact			Intrusive contact
Huronian Series			
Upper Huronian		(Michigamme slate	Slates
		(Bijiki schist	-
		(Goodrich quartzite	Conglomeratic quartzites
Unconformity			Probable unconformity
Middle Huronian		(Negaunee iron formation	Iron formation
		(Siamo slate	Brown slate
		(Ajibic quartzite	-
Unconformity			Unconformity ?
Lower Huronian		(Wewe slate	-
		(Kona dolomite	Quartzite
		(Mesnard quartzite	Limestone or dolomite
Unconformity			Unconformity

(1) Monograph LII, U.S.G.S., pp. 251-252 et seq.

Marquette	Ruth Lake, Labrador
Archaean	
Laurentian - Granite, gneisses	Granite, gneisses
Keewatin - Greenstones	Not found (1)

(1) Not found in Ruth Lake area, but Keewatin-type rocks present in region.

From the lithology and the stratigraphy given above, it is apparent that the Ruth Lake section is almost a bed-for-bed duplication of that of the Marquette Range. The resemblance to the rocks of the Menominee Range is equally as striking. The Lower Huronian of the Menominee consists of a quartzite-dolomite series; the Middle Huronian has the Vulcan iron formation and the Upper consists of the great slate series (Michigamme or Hanbury).

The rocks of the Gogebic and the Mesabi ranges also resemble those of Labrador. The former has been correlated with those of the Marquette and the Menominee (2), although the similarity is not so marked. The Cuyuna Range is found in the great slate series of Upper Huronian age, the equivalent of which probably occurs in Labrador. The Vermilion Range is distinctly different, as the iron formation (Soudan) is in rocks of Keewatin age.

Patches of sandstone, found above the conglomeratic quartzite in Labrador, may be the equivalent of the Cambrian sandstone of the Lake Superior District.

Owing to the preliminary character of the mapping, there are several unavoidable gaps in the information presented on Labrador. Of the several unconformities that exist in the Lake Superior

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(2) Mon. LII, U.S.G.S., Royce, Stephen, Lake Superior Iron Ores, pp.27-53.
Prof. Pap. 184, U.S.G.S., pp. 9-10.

District, only one corresponding has been identified with certainty in Labrador.

Field evidence, though limited, suggests that two others are present. The remaining may be found as mapping proceeds.

The inverted order of the quartzite and the dolomite is a minor point, as the limestone (or dolomite) is known to occur in lenticular form within the quartzite.

The absence of some beds does not present a serious problem, as they may have been removed by erosion or may never have been deposited, owing to the local conditions of sedimentation.

The stratigraphic significance of two bands of conglomerate which occur in the area covered by the Ossokmanuan Lake Sheet is not yet known. It is possible that they are of Keeweenawan age.

For the foregoing reasons, the writer considers that the rocks of the Labrador trough belong to the same general age of Pre-Cambrian deposition as those of the Lake Superior District.

Low was of the same opinion, as he states in his report (1):

"The mode of occurrence of thick beds of magnetic iron ore overlain by cherty, non-fragmental carbonates in this series, closely resembles that of the iron ores of the Lake Superior Region described by Irving, Van Hise and others. This, with other characters of resemblance, renders it almost certain that the two developments represent the same period, or, in other words, that the Animikie rocks of Lake Superior, assumed to be Lower Cambrian, are equivalent to the rocks here described as Cambrian in Labrador."

The occurrence in Labrador of a series of slates comparable

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(1) Geo. Survey Can., Ann. Rep. (New Series) Vol. VIII, 1895, pp.265L-266L.

in age to the great slate series (1) of the Upper Huronian of the Lake Superior District is of great interest. In the latter District, many important deposits of iron ore have been discovered within the slates in addition to the great deposits of Middle Huronian age (2).

GLACIATION

The general marks of glaciation are very numerous within the region. A thin mantle of sand and assorted boulders covers the solid rocks intermittently in the uplands, but almost completely in the lowlands.

In the uplands, the hills have been rounded off slightly by ice action, but the effect of glacial deposition is practically negligible, as few erratics and only a slight veneer of debris, mostly of local origin, are found either on the tops of the hills or in the intervening valleys. Large blocks of slate remain intact, despite the fissile character of the rock, and the other erratics are not well rounded (3).

In the lowlands, although more deposition has taken place, there is no evidence of thick deposits of glacial material having been laid down. Many streams running in different directions are present throughout the region, and their banks have been examined both on the ground and from the air, but at no point were they seen to cut through thick glacial deposits.

Similarly, the effect of glacial erosion appears to be slight. There is no evidence in the uplands of large areas having

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(1) Prof. Pap. 184, U.S.G.S., p.8.
(2) Lake Superior Iron Ores, 1938, p.51.
(3) Geo. Sur. Can., Ann. Rep. (New Series) Vol. VIII, 1895, p.290L.

been sculptured by ice action. The characteristic rounded hills ("roches moutonees"), produced by the abrasive action of a moving glacier, are entirely absent (1). The northern part of the region has actually a closely corrugated surface.

Glacial striae have been observed. They indicate that the ice movement has been south 30° east. Some striae along the deeper valleys are south 60° east, but this is probably due to differential movement along the valley bottom, the movement being purely local.

Eskers occur in several parts of the region. One was observed east of Fitz Lake. It can be traced at least twelve miles. Another was noted southwest of McKay Lake. A third was seen in Wade Lake, running parallel to the west shore. All run in a general north-south direction and attest the former presence of fluvio-glacial streams.

The numerous, small, closely-spaced, irregular lakes have probably been formed in glacial drift. Although not closely examined, they appear to be representative of kamey topography.

The "island" area northwest of Grand Falls, which comprises Sandgirt and Lobstick Lakes is undoubtedly due to glacial deposition. Ashuanipi Lake also contains many islands composed of glacial debris.

A very unique topographic form has been observed from the air in many parts of the region. It is a long-narrow, swampy area with roughly linear, parallel tufts of grass strewn in sinuous form at close intervals across the swamp, with water in the space between the transverse tufts. This topographic form has been named a "festooned marsh". The mode of origin is not clear. The outline

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(1) Opp. Cit. p. 300L.

of each tuft probably represents a piling of fine sand. The piling may be due to successive rainfalls on the sloping end of a retreating glacier. This is only a theory of the writer. Close examination may reveal a different mode of origin.

The fact that there has been little glacial deposition and comparatively little erosion within the region is explained by its proximity to the "Labrador" centre of glaciation (1). Near a centre of continental glaciation, the glacier carries but little load, and hence lacks the more effective implements of abrasive action. For the same reason, there is little material deposited when melting takes place in that part of the glacier which lies close to its point of origin - there is little ground moraine.

THIS POINT HAS A VERY IMPORTANT BEARING BOTH ON THE SEARCH FOR ORE AND ON THE POSSIBILITY OF THE PERSISTENCE OF ORE IN DEPTH.

The light overburden in the northern part of the region greatly facilitates prospecting. When one recalls the thick glacial deposits of the Lake Superior Region, the advantage in searching for ore in Labrador is readily apparent.

Similarly, with regard to the persistence of ore in depth: inasmuch as little glacial erosion has taken place, it is logical to assume that the deposits found in Labrador (or the adjacent area in New Quebec) will persist to at least as great, and probably greater, depths than those of the Lake Superior Region, where much glacial erosion has occurred, and where, in one case, a protective topographic feature, because of its resistance, has a direct bearing

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(1) Opp. Cit. p. 290L.

on the thickness of the deposits (Giant's Range granite on Mesabi Range) (1).

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(1) Lake Superior Iron Ores, p. 48.

PART V

ECONOMIC GEOLOGY

INTRODUCTION

The principal metal of economic value discovered thus far in the New Quebec Area is iron. An extensive area in which numerous sulphide masses and limonitic gossans occur, holds great promise for the discovery of copper-nickel deposits.

On the basis of present knowledge of the region, the following genetic classification of the types of mineralization is presented:

1. Bedded Deposits

   A: Iron ore.

   B: Manganiferous iron ore.

   C: Manganese.

2. Sulphide Replacement Deposits

   A: Massive and/or disseminated pyrrhotite bodies with minor chalcopyrite.

   B: Massive and/or disseminated pyrite bodies.

   C: Pyritized and carbonated zones.

3. Vein Deposits

   A: Quartz with sparse pyrite, pyrrhotite and chalcopyrite.

   B: Calcite with galena alone or sphalerite and galena.

   C: Calcite-quartz-talc veins in sheared serpentinite with smaltite-chloanthite weathering to cobalt bloom (erythrite).

The following description of ore occurrences is based upon their degree of importance rather than upon the above classification. However, most of the types of mineralization are covered in the course of the treatment of each mineral occurrence. This report includes only those deposits which occur in New Quebec.

BURNT CREEK IRON ORE

This deposit was discovered by the writer in 1938 in the course of geological mapping. At the time of its discovery, it was thought to be an extension into Quebec of Ruth Lake ore body No.3, which lies on the Newfoundland side of the boundary. It was determined later, however, that this is a new and different deposit, wholly within Quebec, north of the Ruth Lake ore body.

The ore body is located at the headwaters of a small creek running into Cecil Lake. It is two miles distant from Knob Lake in a west-northwest direction. The topography of the surrounding area is rugged, but in the immediate vicinity of the deposit, the ground is comparatively flat and hummocky, with local elevations of from fifty to sixty feet.

Glacial deposits are very thin, a fact which will greatly facilitate surface work.

The ore is found intermittently along a roughly linear zone, 1,600 feet long, having a northwest trend. A small creek traverses the zone in a northeast direction. The ore concentration occurs within iron formation overlain by fragmental ferruginous quartzite which outcrops abundantly to the northeast. The deposit is located approximately one-quarter mile east of the Slimy Lake fault. Two small transverse faults displace the ore locally and it is drag-folded at the northwest end. At this point, it has a width of sixty feet. Whether or not the deposit is continuous and maintains its width throughout the entire length can only be determined by detailed work. The ore is bluish, heavy and somewhat porous. It resembles hard hematite, although on the surface some is rusted yellow (ordinary rust), probably due to partial hydration. Its appearance is very similar to that of the ores of the Cuyuna Range in Minnesota.

Two grab samples of the ore from the northwest end of the deposit yielded the following results:

	I	II
	%	%
Iron	49.53	2.76
Manganese	13.06	42.35
Silica	2.51	17.11
Phosphorous	0.014	0.05
Sulphur	0.062	0.08
Alumina	- -	0.23

I - Taken in 1938; analysis by J.T. Donald and Co., Montreal.

II - Taken in 1942; analysis by Hollinger Consolidated Gold Mines, Ltd.

Apart from the iron content, two other features greatly enhance the value of this deposit. One of them is the fact that the ore is of Bessemer type (the phosphorous and sulphur content is low). The second important feature is the high content of manganese. The manganese mineral has not yet been identified, as no polished section of the ore is available, but it is probably pyrolusite or manganite.

The presence of manganese is a very important feature. "In a manganiferous ore, up to four or five per cent the manganese is usually calculated as a metal with the iron; that is, the total percentage of iron and manganese in the natural, is used as a percentage of iron calculating the value of the ore. For ores with a higher percentage of manganese than four or five per cent, a special price is usually made." (1)

Surface work and detailed sampling will be required before complete knowledge of this deposit will be available.

DENAULT LAKE IRON ORE

This ore body was discovered about September 1st, 1939, by the writer's former assistant, E.W. Greig. In planning work on the Quebec ground, it was deemed advisable to concentrate efforts on the area that had the greatest possibilities for the occurrence of ore, namely where the geology and structure were similar to those of districts in which iron ore had already been found. This plan of action, combined with the energetic effort of E.W. Greig, is responsible for the discovery of the Denault Lake ore body.

The deposit of iron ore is situated on the east side of a bay which forms the northeast part of Denault Lake. This lake lies close to the height of land and drains north-northwest into the headwaters of the Swampy Bay River. The topography is quite rugged

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(1) Report of the Ontario Iron Ore Committee, with Appendix, 1923; p.88.

to the west of Denault Lake, but to the east, where the deposit is located, it is comparatively flat.

A thin mantle of glacial drift is present in the vicinity of the deposit. This feature will greatly facilitate preliminary development.

The ore occurs as a concentration in the upper part of the iron formation, which is either cross-faulted or drag-folded at this point (drift prevents accurate determinations). The iron formation has a north-northwest trend. It is overlain by the same type of iron-rich fragmental rock that is found at the Burnt Creek deposit. The underlying brown slate does not outcrop at this locality, but it is, in all probability, present beneath the iron formation. White quartzite is exposed farther down close to the edge of the lake.

The deposit is located approximately one-quarter mile east of the Knob Lake fault. This is a very significant point, as the Burnt Creek ore body is also located just east of a big fault (Slimy Lake).

Ore occurs intermittently along a length of 1,260 feet just beyond the east side of Denault Lake. The greatest width observed is 45 feet across. The presence of overburden prevents the determination of the exact surface dimensions of the ore body.

Two thousand feet north-northwest of the main showing, and just north of the lake, another outcrop of ore is exposed. Whether or not the deposit is continuous cannot be determined, owing to the presence of drift. A small outcrop of iron formation is exposed in the intervening area close to the lake, but this may quite conceivably be below the ore zone. It is quite probable that a concentration of ore occurs in the drift covered area, as there is an evident displacement of the iron formation which suggests a fault or a fold, both of which are favourable ore structures.

The ore is soft (relative to the very dense, massive, "hard" ore - an arbitrary term used by Lake Superior iron ore geologists), somewhat porous and slightly limonitic. It is generally reddish-brown, but some specular is present towards the bottom of the zone where the ore is banded.

The results of the analyses of a number of samples follow. It must be clearly understood that this sampling is not systematic. The samples were cut only where the outcrop is found naturally exposed. No surface work has been done on the deposit.

It will be noticed that in some of the samples, the silica content is high. These samples were taken on the margin of the ore. The silica is not uniformly disseminated throughout, but is confined to narrow bands one-quarter to one-half inch wide and could be easily removed. The grade of the ore proper is shown by Sample No. 1, which has an exceptionally high iron content and is of Bessemer type.

Sample No. 1 - Width 45 feet

	As Rec'd.	Dry Basis
Moisture	0.55%	- -
Silica (SiO_2)...........	6.42	6.46%
Iron (Fe)	60.07	60.40
Phosphorous (P)	0.046	0.046
Sulphur (S)	0.027	0.027
Manganese (Mn)	0.076	0.076

Sample No. 2 - Width 7.5 feet

	As Rec'd.	Dry Basis
Moisture	0.67%	- -
Silica (SiO_2)	22.50	22.65%
Iron (Fe)	52.45	52.80
Phosphorous (P)	0.041	0.041
Sulphur (S)	0.021	0.021
Manganese (Mn)	0.043	0.043

Sample No. 3 - Width 10 feet

	As Rec'd.	Dry Basis
Moisture	0.63%	- -
Silica (SiO_2)	8.74	8.80%
Iron (Fe)	54.95	55.30
Phosphorous (P)	0.040	0.040
Sulphur (S)	0.034	0.034
Manganese (Mn)	0.038	0.038

Sample No. 4 - Width 25 feet

	As Rec'd.	Dry Basis
Moisture	0.093%	- -
Silica (SiO_2)...........	14.30	14.43%
Iron (Fe)	52.01	52.50
Phosphorous (P)	0.098	0.098
Sulphur (S)	0.027	0.027
Manganese (Mn)	0.886	0.894

Sample No. 1 was taken on the main ore showing. Sample No. 2 is from the outcrop north of Denault Lake, 2,000 feet north-northwest of the main showing. Sample No. 3 is from the southeast end of the zone. Sample No. 4 was cut close to the lake in the lowermost part of the deposit. All have been roughly channeled.

The information presented above on the Denault Lake ore body is of a preliminary nature. Trenching, test-pitting and systematic sampling will be necessary in order to secure an adequate idea of the grade, the surface dimensions and the structure of the ore.

NEW DISCOVERIES OF IRON ORE

During the course of field work in the Woollett Lake - Kawachik Lake area in 1942, D.R.E. Whitmore located several occurrences of iron ore, which are described below.

Woollett Lake

One-half mile east-southeast of the south end of Woollett Lake, hard blue hematite is exposed at the bottom of two small gullies 200 feet apart. The exposed width is about five feet or more, but since the formations dip 60° east, the actual thickness is somewhat less.

One grab sample submitted for analysis yielded the following results:

	%
Iron	61.35
Silica	12.56
Phosphorous	0.01
Sulphur	0.02

Gunshot Lake

About one-half mile south-southeast of Gunshot Lake and one mile north-northeast of the Woollett Lake occurrence, a hematite-rich bed, three feet wide, is exposed along a length of

25 feet. On analysis, one grab sample yielded the following results:

	%
Iron	59.75
Silica	2.74
Manganese	Tr.
Phosphorous	Tr.
Sulphur	0.23

Kawachik Lake

One-quarter mile west of a small bay on the west side of Kawachik Lake and one mile from its south end, about ten feet of siliceous iron ore is exposed on the side of a hill for a length of 25 feet. Drift covers one side of the outcrop. Because of the very evident siliceous nature of the ore, it was not submitted for analysis.

SUMMARY OF IRON ORE RESULTS (New Quebec only)

LOCALITY	WORK DONE	NO. OF SAMPLES	Fe. + Mn. GRADE	TYPE OF ORE	TONS PER VERT. FOOT (1)
Burnt Creek	Cursory Mapping	2 grab	53.85%	Soft	10,000
Denault Lake	Cursory Mapping	4 roughly channeled	56.65%	Soft	4,000
Woollett Lake	Observed on traverse	1 grab	61.35%	Soft	(Narrow, length unknown)
Gunshot Lake	Observed on traverse	1 grab	59.75%	Soft	(Narrow, length unknown)

(1) Very rough approximations

THE IRON ORES OF THE AREA

The chief iron mineral encountered in the deposits is hematite (Fe_2O_3; 70% Fe). The slightly magnetic character of the ores indicates the presence of a little magnetite (Fe_3O_4; 72.4% Fe) associated with the hematite. The ore contains a small amount of moisture, signifying the slight hydration of the hematite, probably represented by the presence of the hydrous iron oxides, limonite ($2FeO.3H_2O$; 59.8% Fe), turgite ($2Fe_2O_3.H_2O$; 66.2% Fe.) or goethite ($Fe_2O_3.H_2O$; 62.9% Fe). Siderite ($FeCO_3$; 48.2% Fe) was not observed anywhere in the ore, although it is present in some of the iron formation.

In addition to the above, the Burnt Creek ore contains some manganese mineral or minerals, which is probably pyrolusite ($MeO_2 + H_2O$) or manganite ($Mn_2O_3.H_2O$).

The ores of the Knob Lake, Burnt Creek, Ruth Lake deposits are usually brownish-red in colour and in places somewhat porous. Because of its porous character, the ore is "soft". The term "hard" is reserved for the very dense, massive, often micaceous type such as that which occurs at Sawyer Lake. The term is somewhat ambiguous, as both ores are hard. The degree of hardness of the latter is, however, much greater. Specular (bluish hematite) forms a small proportion of the ore. This type of "hard" hematite is often referred to as "lump" ore.

Most of the ore found to date is of Bessemer type. This means that it has low phosphorous and low sulphur. The amount of phosphorous is the criterion of the type, as the sulphur can be slagged off as calcium sulphide in the blast furnace. Low phosphorous, however, is usually accompanied by low sulphur. The amount of allowable phosphorous in pig iron produced from ore of Bessemer type is 0.1 per cent. This means, theoretically, that the allowable phosphorous is 0.001 per cent for each per cent of natural iron. However, the flux and the fuel often contain a small quantity of phosphorous, and as a consequence, the amount allowed is actually less than the theoretical limit. At present, the phosphorous allowed in an ore of Bessemer type carrying 51 per cent iron (Lake Superior standard grade) is 0.045 per cent (1) or .0009923 per cent for each per cent of natural iron.

The siliceous iron formation always stands out as a marked topographic feature similar to the "Ranges" of the Lake Superior District. The ore deposits found thus far (with exception of Sawyer Lake, which consists of "hard" ore) occur in the less prominent parts of the formation. At one of the Ruth Lake deposits, the erosion of the soft ore has produced slides along the precipitous face of the iron formation. The striking character of this topography led to the discovery of the ore.

PROSPECTING FOR IRON ORE

The concentration of ore in the Lake Superior District is controlled by folds, faults and dyke intersections (2). In the region, the deposits thus far discovered occur in drag folds close to big thrust faults. As field work proceeds, ore will probably be found in other structures. In prospecting for iron, structures similar to those mentioned above should be sought. The concentration of ore has probably been brought about by the leaching of silica from iron formations through the circulation of ground water down the channels

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(1) Lake Superior Iron Ores, p.283.
(2) Mon. LII, U.S.G.S., p. 475; Lake Superior Iron Ores p.29.

formed by the structures, hence the reason for seeking them.

Geological maps, prepared over a period of years, show the approximate location of the iron ore horizon. They are invaluable in the search for iron ore deposits.

An important point in connection with prospecting in Labrador is that much less overburden is present than in the Lake Superior District. This greatly simplifies the work.

There is a magnetic horizon at the base of the iron-rich conglomeratic quartzite, which may prove to be useful in dip-needle work in drift-covered areas.

POTENTIAL COPPER-NICKEL AREA

Location and Extent

The potential copper-nickel area begins at the north end of Andre Lake and continues north-northwest to a point just north of Retty Lake, a distance of forty-five miles. It extends in an easterly direction from Frederickson Lake down the George River (west branch) for a distance of thirty miles. Additional mineralization has been found close to Louis Lake, approximately thirty miles northwest of Retty Lake, and around Dominique Lake, thirty miles northeast of Retty Lake. Whether or not mineralization occurs in the intervening ground is unknown.

The southwest part of the area lies in Newfoundland territory, the remainder in Quebec.

The area outlined above is more commonly referred to as the "gossan area", because gossans are of common occurrence within it.

History

In the course of work for the New Quebec Company in 1929, Dr. J.F. Gill made an aerial sketch of the upper part of the George River (west branch) and in all probability observed some of the very conspicuous gossans, although no mention of it is made in his report.

In 1936, Dr. J.S. Wishart, one of the geologists of the 1929 expedition, who was also a member of the 1936 expedition, informed the writer that he had seen gossans from the air at the head of the George River. Wishart made a rapid ground reconnaissance of the upper part of the George River for the James and Gill expedition.

In September, 1936, at Ferguson's trading camp on Ashuanipi Lake, Dominique Docteur, an Indian from the Seven Islands reserve, showed the writer several specimens of pyrite and pyrrhotite from his trapping ground on the George River. Docteur agreed to conduct the writer to the spot, and he and his family were loaded on the plane and together with Pilot A.G. Sims set out for the George River. Just short of the proposed destination, a blinding snowstorm forced the pilot to return to Attikamagen Lake, where the Indian and his family were left behind and the journey abandoned, owing to the lateness of the season.

During the flight, the writer made a rough sketch of the upper part of the George River and observed one gossan. At that time, both the pilot and the writer were more concerned with location in unmapped country than with anything else.

In the summer of 1937, Dominique Docteur, the above-mentioned Indian, was brought from Seven Islands. The George River trip was carried out and several pyrite and pyrrhotite zones located. On two flights over the area, both the pilots and the writer observed several gossans close to the river, the most prominent of which were at a lake, later called "McNeill Lake", after J.E. McNeill, the prospector who was sent to examine the gossans. McNeill located four gossans, two of which were large, but the only mineral of value reported was chalcopyrite in float. The writer examined the large gossan about three-quarters of a mile northwest of the lake, but the hopelessness of attempting to uncover it with limited man-power forced upon him the decision to postpone the investigation to a later date.

During the same season (1937), H.M. Towle, who mapped the topography reported considerable rust around "Rusty Lake" and found a small patch of chalcopyrite on Marion Lake.

In 1938, the writer, while supervising the opening-up of the Sawyer Lake Deposit, spent one week on Marion Lake and located the rust-coated pyrite-carbonate zones.

From the above, it is evident that the occurrence of gossans on the George River (west branch) was known as early as 1929. They were re-discovered in 1937, and in that year and 1938, some work was done in the area.

During the past season, at the suggestion of the writer, four out of twelve parties were put into the "gossan" area at the beginning of the season. The prospector, J.E. McNeill, who was again a member of the expedition, was put down on the same lake in the "gossan" area (McNeill Lake).

As work progressed and more flights were made over the area, new gossans were observed and the field greatly extended, so that the original number has been increased greatly.

Geology

The area in which the gossans occur is underlain by Keewatin-type rocks, consisting of folded tuffs, lavas and carbonaceous interflow sediments with minor conglomerate and quartzite. The lava series is cut by dykes and/or sills of intermediate to basic composition.

The prospecting and geological work of the past season disclosed the existence of numerous sulphide bodies and many gossans in the area.

Sulphide Replacement Bodies

Pyrrhotite

By far the greater number of sulphide bodies found to date consist of pyrrhotite. Present knowledge indicates that they are confined largely to the area underlain by Keewatin-type rocks. Some few occur in sedimentary schists in the vicinity of Dominique Lake in New Quebec.

The bodies dip from 20° to vertical, and generally strike northwest parallel to the regional trend. Sufficient work has not been done to determine their shape, but it is probably tabular, although the outlines of replacement bodies are usually very irregular.

The majority of the occurrences are replacements of thin beds of carbonaceous tuffs. In some few cases, the occurrences are at the contact of gabbro or diorite dykes with lavas. The latter type is usually small. A.T. Griffis, who examined thirteen bodies along or close to the George River, states that eleven are replacements of carbonaceous tuffs, while two occur at the contact of intrusives with lavas.

The deposits vary greatly in size. Some are large, while others are small. Prospectors Frederickson and Connolly reported a mass south of Doublet Lake, which is approximately 150 feet wide and 1500 feet long.

The pyrrhotite varies considerably in appearance. Some is fine-grained and has a distinctly greyish hue. More of it is coarse and bronze-like. Two generations were observed in one specimen, the coarser, bronze-like type cutting the fine-grained, steely type. Minor chalcopyrite is usually associated with the pyrrhotite. It occurs generally in veinlets or tiny patches, and occasionally as an intergrowth. A small amount of quartz was observed in one sample.

The carbonaceous tuffs exhibit all degrees of replacement. In one specimen the host rock is a partly-replaced volcanic breccia. The few examples of disseminated types are replacements of diorite or gabbro.

Sampling and Prospecting Pyrrhotite Bodies

Because of the great number and size of the pyrrhotite bodies, only the most cursory investigation of them was possible. Comparatively few were examined by geologists. One or two grab samples, however, were taken by prospectors from all bodies located. Analysis yielded only low values in copper and nickel, with negligible gold and silver.

Close prospecting and sampling of these occurrences appears to be warranted, inasmuch as detailed work might produce results of economic value.

Economic Significance of Pyrrhotite Mineralization

Studies of ore deposits have demonstrated repeatedly that pyrrhotite and nickel are genetically associated. Pyrrhotite containing either nickel (nickeliferous pyrrhotite) or the nickel mineral (pentlandite), together with copper (chalcopyrite) is the mineral association at the famous copper-nickel deposits of Sudbury, Ont. (1). The conclusion is therefore inevitable that wherever masses of pyrrhotite are found, they merit careful investigation. Only low percentages of nickel and copper have been found, but detailed sampling and prospecting might yield results of ore-grade.

Pyrite

The massive pyrite bodies are few in number. They occur in Keewatin-type rocks and replace carbonaceous tuffs. The pyrite is usually dense and fine. In some of the specimens collected, the primary bedding of the tuffs is retained.

Disseminated bodies occur in rock-types of all ages. In some the pyrite is fine-grained, in others it is coarse.

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(1) Mineral Deposits, Lindgren 1928, p.90.

The pyrite discovered to date has no commercial value. It has potential value in that it may be used as a source of sulphur at some future time.

Gossans

"Gossan" is an old Cornish term applied to the rusty product resulting from the superficial weathering of the iron-rich minerals of veins through oxidation and hydration. The gossans of Labrador are rusty or yellowish-brown in colour, comparatively soft and often honeycombed. The size varies considerably, but many are large. Nothing is known of the shape.

The geologic history of the gossans of Labrador is of very great importance, because of its bearing on exploration. Because of the paucity of information, little but speculation is possible concerning the mode of origin or the depth of oxidation of most of the rusty zones. The question to be decided is: are the gossans transported material derived from the recent weathering of sulphide masses, or do they represent residues resulting from weathering in place largely of preglacial origin?

Recent Origin ?

The origin of some of the gossans along the upper George River has been discussed by A.T. Griffis (1). He writes as follows:

"The gossans are rusty limonitic deposits which are clearly visible from the air. Usually, these occur on the side or near the base of a hill, and may be sheets of pure limonite 'sand' up to hundreds of feet wide, are often of very irregular outline, and may

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(1) Private report to Labrador Mining and Exploration Co. Ltd.

be up to a mile in length. In the typical case the limonitic material appears to be a 'wash' and small creeks and ponds are often found in or on the gossan.

Several were examined and it was found that the limonitic sand is underlain at about 6" depth by a hard stratified layer of limonite, which always slopes downhill and appears to be of fairly recent origin, since fragments of leaves, wood and even pebbles have been replaced by the hydrous iron oxide. It was also noted that boulders of talus on the sides of several hills have been engulfed or covered by the deposits. Some of the limonitic material must have been pre-glacial or at least older than the last phase of glacial activity. This is shown at the gossan near the outlet of Doublet Lake, where much of the gossan material has been swept uphill from the sulphide body and now lies in an irregular windrow of limonitic debris."

In view of the above observations, the writer (Griffis) concludes that the gossans represent recent deposition of limonitic material by ground waters. These waters could very easily have picked up their iron content by working down to the sulphide zones and thence to the surface, where deposition takes place. The limonite gradually forms into a sheet and may be carried downhill by frost or stream action or rock slides. The gossans are not, therefore, cappings of deeply weathered sulphide bodies, but are merely a consequence of recent weathering of sulphide bodies.

Whether or not the conclusions of Griffis may be applied generally is not known. His work was limited to the vicinity of the George River. If his conclusions hold true for the whole region, there must have been considerable leaching of the sulphide masses since glaciation. The difference in the resulting mass would be quite pronounced, as if of recent origin, the material would be removed by streams as quickly as formed, and the oxidized capping would be inconsequential. However, this condition might apply only to the sulphide masses along streams. In any case, the depth of recent weathering in any of the sulphide masses would be shallow.

Preglacial Origin ?

That the gossans may be the result of preglacial weathering is suggested by the following:

1. The region has been glaciated, but the comparative proximity of the centre of glaciation has lessened the scouring effect of the ice, because near its source a glacier lacks the effective implements of abrasion. While there is no evidence of thick preglacial soils remaining from the weathering of surficial rocks, it is probable that the sulphide masses were more deeply weathered than the surrounding rocks and that the gossans are remnants of the deeply-weathered zones that have escaped glacial erosion.

2. Many gossans are found in low ground in which the gradient is slight. The water-table is consequently at a low level and the transporting power negligible. This suggests a preglacial origin.

3. It is possible, but highly improbable, that so much weathering has taken place since glacial time.

Economic Significance of Gossans

Gossans of recent origin formed by the accumulation of ferruginous material transported by streams are of no significance whatsoever. They are shallow, superficial deposits. Investigation of these would be a waste of money. It would be much more logical to trace the material to its source and sample the solid sulphides from which they are derived.

Gossans formed in place, probably largely in preglacial time, merit careful investigation. They are the weathered remnants of mineralized bodies and the parent subjacent mass might well prove to be of economic interest. The writer is of the opinion that these would probably be more favourable than the exposed solid sulphide bodies, because, if other minerals such as compounds of copper or nickel were associated with pyrrhotite, the mass would disintegrate much more rapidly than if it were composed of pyrrhotite alone, owing to the greater solubility of those compounds.

There should be little difficulty differentiating between the two types of gossan-material. Gossans produced by the deposition of transported iron compounds are usually composed in part of unweathered fragments of varying composition, whereas the true gossans show no trace of such fragments and are often honeycombed. Studies of the boxwork of the true gossans may yield some information as to the type of mineralization present before weathering took place.

VEINS

Quartz

Quartz veins have been found throughout the area in rocks of all ages. Pyrite, pyrrhotite, chalcopyrite and negligible galena and sphalerite occur in the veins. Thus far none has disclosed anything of economic interest.

Calcite

A three-foot calcite vein carrying sphalerite and galena in small amount occurs to the east of Volcanic Lake. It holds no present economic interest.

Calcite - Quartz - Talc - Cobalt Bloom

At two known localities the serpentinite has been sheared. Within these shears, lenses of quartz, calcite and talc occur. The calcite contains narrow seams of smaltite-chloanthite. This mineral shows the characteristic weathering to cobalt bloom (erytherite). These occurrences are of potential economic value and merit additional prospecting.

OTHER KNOWN POSSIBILITIES

Extensive sheets of serpentinite are known to occur at many points in the George River Series. The constant association of asbestos and chromite with ultrabasic rocks is a well known geological fact (1). Thus far, neither of these minerals has been discovered in the area, although narrow veinlets of picrolite have been located. Detailed prospecting of the serpentine belts might

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(1) Lindgren, W. Mineral Deposits, 1933, pp. 877-878.

yield mineral deposits of economic importance.

CONCLUSIONS

1. The area is so large and the record so complex and incomplete, that this report simply attempts to disclose some of the major geological problems and thus afford a better method of attack on them when field work is resumed.

2. Several deposits of iron ore have been discovered in the region under geological conditions which greatly resemble those of the Lake Superior District, one of the most important iron ore fields of the world.

3. The Labrador trough of late Precambrian sediments is 300 miles long and 30 to 40 miles wide. Iron formation has been found at many points both across and along the strike. The potentialities for the discovery of new deposits of iron ore are obviously very great.

4. Additional work on the gossan area has disclosed that it holds possibilities for the discovery of copper-nickel deposits.

5. This is one of the largest areas of Precambrian rocks in the world which has not been prospected. It will doubtless yield deposits other than those mentioned above.

6. Grand Falls, probably one of the largest undeveloped sources of hydro-electric energy, lies comparatively close to the areas of actual and potential economic interest.

7. Preliminary observations of the writer indicate that there would be no great engineering difficulty associated with building a railroad to the area along the Romaine River Valley.

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