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DEPARTMENT OF MINES
HON. CHARLES STEWART, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

GEOLOGICAL SURVEY
W. H. COLLINS, DIRECTOR

Summary Report, 1925, Part C

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OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1927

No 2118

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SUMMARY REPORT, 1925, PART C

MINERAL DEPOSITS OF STEEPROCK LAKE MAP-AREA, ONTARIO

By T. L. Tanton

CONTENTS

INTRODUCTION

Steeprock Lake map-area lies between latitudes 48° 45′ and 49°, and longitudes 91° 30′ and 92°, in Rainy River district, Ontario. The Canadian National railway runs approximately along the southern edge of the area of which Steeprock lake, an expansion of Seine river, is a prominent geographic feature. Detailed geological mapping was commenced in 1925 and during the progress of the work various mineral occurrences were examined. These are described in this report.

The writer was ably assisted in the field by H. M. Bannerman, H. Kranck, and W. S. Yarwood.

Seine River sheet[1] is the only published geological map that includes the entire map-area. A map showing the geology of Steeprock lake appears in "Twelfth International Geological Congress, Guide Book No. 8, pt. I, p. 48 (1913)," and in this publication W. L. Uglow gives a concise description of features of geological interest and a bibliography of geological literature.

In addition to the report by W. McInnes and W. H. C. Smith, the following reports deal with mineral occurrences of the area.

Bruce, E. L.: Ont. Dept. of Mines, Ann. Rept., vol. XXXIV, pt. VI, pp. 30-32 (1925).
Carter, W. E. H.: Eleventh Rept. Ont. Bureau of Mines, pp. 241, 265-266 (1902).
Coleman, A. P.: Fourth Rept. Ont. Bureau of Mines, pp. 58-59, 73-76 (1894).
Sixth Rept. Ont. Bureau of Mines, pp. 78-79 (1896).
Eleventh Rept. Ont. Bureau of Mines, pp. 133-134 (1902).
Fraleck, E. L.: Ont. Bureau of Mines, Ann. Rept., vol. XVI, pt. I, pp. 173-175 (1907).
Lindeman, E., and Bolton, L. L.: Mines Branch, Dept. of Mines, Canada, "Iron Ore Occurrences in Canada"; Pub. No. 217, vol. II, pp. 51-52 (1917).
Miller, W. G.: Twelfth Rept. Ont. Bureau of Mines, p. 309 (1903).
Robinson, A. H. A.: Mines Branch, Dept. of Mines, Canada, Sum. Rept. 1918, pp. 18-20.
Wilson, A. W. G.: Mines Branch, Dept. of Mines, Canada, "Pyrites in Canada"; Pub. No. 167, p. 74 (1912).

[1] Geol. Surv., Canada, Map No. 560. The map accompanies a report by McInnes, W., and Smith, W. H. C.: Geol. Surv., Canada, Ann. Rept., vol. X, pt. H (1899).

Scores of mining claims have been taken up throughout the southern part of the map-area following periods subsequent to 1894 of active prospecting for gold, iron, and pyrite. The latest mining operations ceased in 1914. The present commercial activities are confined to lumbering in the northwest quarter of the map-area and the installation of an hydro-electric power plant at the falls on Seine river above Steeprock lake.

IRON ORE

Concentrations of iron-ore minerals occur at numerous localities throughout the area which has been mapped[1] as underlain by Keewatin rocks. The concentrations are of various mineral compositions, are disposed in a variety of ways with respect to the associated rock, and are not all of the same age. At nearly all of the localities mentioned below there is evidence of stripping or other development work performed many years ago.

(1) Belts up to 80 feet wide of lean, banded iron formation occur among Keewatin lavas at the following localities: an island at the north end of Niven lake; 200 feet south of Banning station; south shore of Buttermilk lake near its east end; half a mile south of the south end of Buttermilk lake; on the three adjoining mining locations 140 E, 139 E, and 145 E, north of Perch lake; on the west shore of Arnold lake, 1 mile north of the last-mentioned location; mining locations K 135 and K 137 adjacent to the western part of Steeprock lake; on mining location 858 X south of the west end of Strawhat lake; and adjacent to the railway, near mile-post 5, west of Atikokan. Considerable trenching and stripping have been done on certain of these belts.

The iron formation consists of thin layers of fine-grained magnetite alternating with layers of fine-grained silica which preponderate in volume. Variations in the widths of single layers and groups of layers are common. The layers are nearly vertical and in many places are contorted. In general the iron formation is similar to that found in the Keewatin of the Matawin River map-area,[2] but the belts are narrower and though parts of some belts are richer in iron than other parts, it is the belief of the writer that the chance of discovering iron ore-bodies is remote. Nowhere was a width of more than 10 feet observed to have an iron content appearing to exceed 25 per cent and by far the greater part of the banded iron formation is much leaner.

(2) Banded iron formations very lean in iron occur in the Steeprock series. One belt a few feet wide occurs on the northeast side of the east arm of Steeprock lake within the Steeprock limestone. It consists of alternating layers averaging about half an inch thick of red and grey chert. Within the cherty material at certain places there is some iron-bearing carbonate and hematite.

[1] Geol. Surv., Canada, Map No. 560 (1897).
[2] Tanton, T. L.: Geol. Surv., Canada, Sum. Rept. 1924, pt. C.

On the southwest side of the east arm of Steeprock lake there is a belt of banded iron formation over 100 feet thick and traceable for 200 feet across the base of Greenstone point. It consists of layers of pale grey and rusty brown chert averaging an inch in thickness, with fairly regular interlaminations, averaging ¼ inch in thickness, of a massive, dense, hard, black material consisting chiefly of an intimate mixture of magnetite and limonite. The iron content of this material is estimated by the writer not to exceed 15 per cent. On the west shore of the main peninsula projecting into the northern part of Perch lake, a dark grey, slaty iron formation is exposed adjacent to, and conformable with, a conglomerate which lies south of it. The beds strike east-northeast and are vertical. The slaty iron formation is lithologically identical with a slaty iron formation of Windigokan (?) age which occurs in the Matawin iron range. Within the dominantly slaty material are groups of beds containing an intimate mixture of magnetite and hematite and in them are several thin, discontinuous layers of red jasper. A pit and trench near the shore of Perch lake reveal a group of highly ferruginous slaty beds about 15 feet thick. The exposed material is not sufficiently rich in iron to be regarded as iron ore.

(3) Large masses of carbonate rock occur within the Steeprock series. By far the greater part is secondary material which has replaced lava, tuff, and limestone beds. Masses of these rocks with indefinite boundaries occur through the carbonate. Prominently displayed developments of the carbonate occur at several widely separated places on the islands and northern shores of Steeprock lake. At these localities the carbonate masses ramify through a thinly-bedded, cherty limestone and, also, lavas and pryroclastics. These masses of partly replaced limestone and volcanic rocks have been referred to by previous writers as constituting the Steeprock limestone member of the Steeprock series, although stratified limestone forms less than 10 per cent of the rock. The stratified rock to which the name Steeprock limestone might properly be applied is not highly ferruginous. It weathers various shades of grey and occasionally white and buff. The secondary carbonate rock is characteristically ferruginous, as is indicated by the rusty coating on weathered surfaces; it is dense, fine-grained, and massive. It contains irregular-shaped segregations of white calcite, vugs lined with beautiful red, and colourless quartz crystals occasionally 2 inches long; abundant tiny chert nodules, and masses of various lavas and sediments in various stages of replacement. The carbonate rock as developed over a length of about 12 miles along the shore of Steeprock lake forms isolated hummocks rising 100 feet above the lake and having diameters of several hundreds of feet. It is reasonable to suppose that the carbonate rock was at one time more extensive than now. If it had been partly destroyed by solution, residual masses of limonite of considerable thickness might have developed and such limonite might have been concentrated in adjacent lowlands such as the bed of Steeprock lake. The most favourable place for such accumulations of limonite would be the bed of the east arm of Steeprock lake. No information is available regarding the character of the materials at the bottom of the lake, though water lots have been taken up as mining claims along this part of the lake.

Carbonate rock largely concealed by drift, but possibly 600 feet by 300 feet in area, occurs on Birch point, on the west arm of Steeprock lake. Side-hill pits expose in two places a crust of limonite a foot thick on the surface of the carbonate. There is no reason to suppose that this limonite is more abundant on Birch point than at other places along the lake shore where the carbonate masses are well exposed, and in general it is evident that the limonite coating is too thin to be mined economically.

The great carbonate masses on Elbow point and on the north shore of Falls bay contain relatively small, angular masses mainly of red, earthy hematite. One such mass on Elbow point measures approximately 7 feet by 3 feet and at the surface consists of red hematite with minor impurities. In the vicinity of these occurrences there are unreplaced blocks of basalt distributed in a very irregular manner through the carbonate rock and examples form a transitional series from blocks of basalt to masses of hematitic material with intermediate stages consisting of basalt impregnated with and partly replaced by bluish grey carbonate. In such masses where carbonate is prominently developed, there is a peripheral zone of hematite which fades out along irregularly bounded seams and tongues in the interior of the blocks. The pockets of hematite in carbonate as developed about Steeprock lake are too small and too irregularly distributed to be regarded as a probable source of iron ore.

Ferruginous carbonate replacement bodies occur at numerous localities in the map-area in association with rocks other than the Steeprock limestone. In some cases the internal structure, and some of the minerals, of the replaced rock, persist; in other cases the replacement has been complete and the evidence that it is a replacement is presented by the irregular shape of the mass, the tongues of carbonate ramifying through the adjacent rock, the residual masses of country rock within it, and the continuity of internal structures with those of the surrounding partly replaced rock. Ferruginous carbonate deposits occur in the Couchiching schists; in Keewatin lavas; in the schistose sediments of Clearwater lake which have been tentatively correlated with the Steeprock series; and in basic intrusives of post-Steeprock age. Many of these bodies have dimensions of hundreds of feet. The weathered surface of these masses is coated with limonite which is seldom more than an inch or so thick. Some attention has been given to occurrences of the carbonate in the search for iron ore. On a claim one mile north from the outlet of Steeprock lake, Mr. Thomas Rawn drilled a carbonate replacement body in Keewatin lavas and found, beneath the thin outer scale of limonite, unweathered carbonate to a depth of 400 feet. Quartz veins are abundant in the carbonate of this locality and in many of the other larger carbonate masses. Occurrences of this nature are not regarded by the writer as a probable source of iron ore. (4) Half a mile southeasterly from the northern end of the east arm of Steeprock lake and about 250 feet inland from the western shore, there is a cliff about 20 feet high and traceable southerly for about 200 feet. The rock here exposed appears to be made up of light and dark green fragments of earthy material averaging between ¼ and ⅛ inch in diameter, lying in a matrix of chert and ferruginous carbonate. A few lenses of chert, up to 4 inches in length, are irregularly distributed through the rock. No bedding is apparent; but in places the rock is schistose. A sample of the rock was analysed by M. F. Connor of the Geological Survey with the following result:

	Per cent		Per cent
SiO_2	87·88	MnO	0·008
Al_2O_3	4·90	Na_2O, K_2O	2·00
Cr_2O_3	0·12	P_2O_5	0·04
Fe_2O_3	0·45	Loss on ignition	1·54
FeO	2·20		
MgO	0·56		
CaO	0·20		99·898

The rock at the top of the cliff has apparently been replaced by dense, hard, brown limonite through which there is a system of tiny vugs and branching cavities defining a pattern somewhat like that in the earthy, green fragmental rock. The limonite is known to be 3 feet thick for 40 feet along the cliff. Limonite boulders in the drift to the south and south-west of this locality consist of material such as this and are said to have induced early prospectors to believe that rich iron ore was to be expected in this region. Mr. J. E. Marks informed the writer that the above-mentioned limonite outcrop was discovered by him comparatively recently and that no development work on it had been done. The limonite occurrence lies in an area that is mainly drift-covered; on all sides the nearest outcrops are of basic lavas and pyroclastics of the Steeprock series. In the writer's opinion conditions warrant an attempt to trace a continuation of the limonite occurrence in the hope of discovering a much larger mass, which might be of commercial value. The direction from which the latest glacial sheet advanced over this region is approximately north 15 degrees east and residues of surface formations which contributed boulders to the till are probably better preserved on the southern sides of rocky prominences than on the northern. This consideration may be found of value in exploring the hilly area in the vicinity of the limonite occurrence.

(5) In the vicinity of Steeprock lake numerous dykes and irregular-shaped masses of gabbro intrude the sedimentary rocks of the Steeprock series. In some localities these rocks are fine grained, and closely resemble certain phases of the basic lavas of the Steeprock series. Where the gabbro intrusives penetrate the iron formation of the Steeprock series they contain an abnormally large amount of magnetite and iron sulphides. These minerals are irregularly disseminated through the rock and locally are concentrated in lenticular masses which attain lengths of scores of feet. Several occurrences of this nature have received the attention of prospectors in the southeastern part of the map-area, but, although the geological relationships appear very similar to those obtaining in the case of the iron ore deposits of the Atikokan iron mine, no large concentrations of sufficient purity to be regarded as ore have yet been found. In a narrow zone extending nearly due east from the map-area to Atikokan iron mine, 10 miles distant, there are said to be several exposures of gabbro or related rock containing local concentrations of magnetite more or less intimately mixed with pyrite and small amounts of pyrrhotite.

(6) A few hundred feet southeasterly from the east end of Strawhat lake a relatively thick gossan consisting chiefly of a porous mass of limonite and hematite occurs over a pyrite-bearing, ferruginous carbonate body. The average thickness of the gossan, as exposed in a trench, is one foot, but oxidation has proceeded along certain channels to greater depth. Development work on the pyrite occurrence has clearly exposed the iron oxide deposit over an area measuring 300 feet in two dimensions, on the eastern end of a ridge which rises 30 feet above Strawhat lake. The available information does not indicate that a workable body of iron oxide ore occurs at this locality.

PYRITE

On mining locations 857 X and 858 X, a mass of pyrite-bearing, ferruginous, carbonate rock 250 feet wide and 450 feet long extends, as a ridge 30 feet high, southeast from the eastern extremity of Strawhat lake. Along the northern margin are basic lavas and pyroclastics partly replaced by carbonate; drift conceals the southern edge, but basic lavas outcrop on a parallel ridge about 400 feet southwest. Exploration work was conducted in 1902-3 and in 1909, by the Oliver Iron Mining Company, and consists of trenches and test pits on the southeastern end of the ridge, and four diamond-drill holes.

Across the northwestern end of the ridge, where there are low cliffs near the lake, the ferruginous carbonate locally carries narrow, irregular seams and small blotches of fine-grained pyrite which, however, forms only a very small percentage of the rock. The southeastern end of the ridge, where the gossan has been removed in pits and trenches, consists of ferruginous carbonate with irregularly distributed small seams and nodules of chert, and an interlacing network of pyrite stringers and seamlets which unite and divide so as to produce the appearance of a breccia, in which the sulphide-rich material surrounds large and small angular masses containing less pyrite. The richly pyritized rock contains occasional masses of finely-crystalline, pure pyrite, a few inches in maximum diameter. Diamond drilling is said to have revealed pyrite under the drift in a gully west of the exposed deposit. The irregular mode of distribution of the pyrite, in the relatively rich, sulphide-bearing rock does not permit of a close estimate of the size of the deposit. At the eastern end of the ridge in a crescent-shaped area measuring 300 feet from tip to tip and 140 feet across the widest part, the pyrite is estimated by the writer to make up approximately one-third of the volume of the rock exposed. Masses consisting chiefly of a pyrite and having maximum dimensions of a few feet are sparsely distributed through the rock.

On mining locations A.L. 460, 461, and 462 on the west shore of the northwestern part of Steeprock lake, a pyrite vein, at least 600 feet long, trends in a southerly direction. Five diamond-drill holes were bored in 1903 for the owners, Mackenzie and Mann. At depths from 95 to 167 feet these showed from 6 to 21 feet of pyrite, samples of which yielded 43·8 to 48·8 per cent S, 38·4 to 43·2 per cent Fe, and traces of phosphorus. The vein traverses graphitic slate and chlorite schist. Since 1903 no development work has been done on the deposit.

GOLD

The known gold occurrences in the map-area lie northwest of Steep-rock lake within a contact zone, 2 miles in width, between an assemblage of Keewatin green schists and an intrusive granite batholith. The zone is mainly underlain by a complex of granitic rocks, large, irregular-shaped masses of green schists, and a variety of hybrid rocks which are commonly porphyritic. Within the zone are a number of small dykes of soft, dark green, massive rock consisting chiefly of chlorite and a carbonate which at some localities weathers to limonite, together with minor amounts of quartz. These dykes are probably altered lamprophyres.

A large number of veins and pegmatite dykes occur throughout the contact zone. Although pyrite-bearing quartz veins have been examined by prospectors at many localities within and adjacent to the contact zone no gold has been found. The known gold occurrences, four in number, are restricted to quartz veins visibly mineralized with chalcopyrite.

At Harold Lake mine a vein rich in gold is said to have been found and worked out; particulars regarding values and production are not available. The property, mining location 219 X, is on the west shore of Harold lake. During 1895 and 1896 a 5-stamp mill was in operation, since that time it has been idle. The buildings have been destroyed by fire. On the vein near the lake shore a shaft was sunk 37 feet. At a depth of 27 feet, a drift was driven north 10 feet. About 100 feet south-southwest from the shaft an adit was driven along the main vein for 127 feet and between 80 feet and 105 feet along the adit, the vein was stoped 20 feet to the surface. At 60 feet along the adit a 6-foot by 9-foot winze was sunk 49 feet. Another adit known as No. 1, and a second shaft (or winze) 17 feet deep, were excavated; the positions of these have not been recorded.

The first-mentioned shaft is 30 feet west of the lake. The collar of the shaft is a few inches above high water-level and is at the base of a 30-foot cliff of greenish grey quartz porphyry and sericite schist, cut by a network of quartz veinlets. No large vein is now visible, but the dump from the shaft is made up chiefly of vein material composed of milky quartz and ferruginous carbonate with minute quantities of pyrite and chalcopyrite. The trend of the vein reached by shaft is inferred to be north 15 degrees west.

The vein mined in the main adit has been said to have been traced 130 feet and to have averaged 4 feet in width. It strikes north and dips 60 degrees east. Where the vein is now visible, south of the stope, it is 2 feet wide narrowing southward. A zone of sericite schist a few inches wide borders the vein; the country rock is pink and grey quartz feldspar porphyry cut by numerous quartz veinlets, apparently unmineralized. The vein material is finely crystalline, sugary quartz carrying disseminated pyrite, chalcopyrite, and galena.

The Elizabeth mine is a quarter of a mile north of Rice lake and 1½ miles northeast from Harold Lake mine. The property consists of claims F.M. 171 and F.M. 172, comprising 373 acres.

Gold-bearing veins were discovered and the claims taken up in 1900 by the Anglo-Canadian Gold Estates, Ltd., of London, England. Development work, including diamond drilling, was carried on by this syndicate. It has been reported that early in 1903, 20,000 tons of ore had been blocked out, which it was believed would average $8 to $10 a ton. In 1902 a 10-stamp mill was installed. In 1912 mining and milling operations were carried on for part of the year. All work was discontinued August 1, 1914. Following a period of litigation, the property was purchased in 1923 by the Goldex Mining Corporation, Limited, Montreal, of which Auguste Chausse is president and M. O'Halloran secretary treasurer. Mining operations had not been resumed when the property was visited in 1925.

The ore-body in which the main shaft, known as No. 2, was sunk has been described as a vein trending north and south, varying in width, by reason of lenticular enlargements, from 1 to 14 feet, and accompanied along its narrow parts by parallel veins. It was estimated that the vein system has an average width of 5 feet. According to a vertical section in a prospectus issued by the Goldex Mining Corporation, the ore-body mined out was 75 feet long and 150 feet deep. The average value of the ore is stated to have been $10 per ton. An ore-shoot averaging $40 per ton is said to have been traced over a length of 100 feet and to have been mined within the ore-body from the surface to a depth of 150 feet. A diamond-drill hole sunk at an angle of 45 degrees for 60 feet from the third level, 250 feet below the surface, is said to have penetrated a 5-foot vein carrying $32 in gold to the ton.

Four hundred feet south of shaft No. 2 is shaft No. 1, 110 feet deep with a short drift at the first level. Ore averaging $10 to the ton is said to have been found at this locality, but the shape and dimensions of the ore-body have not been reported.

The vein system which was mined could not be identified by the present writer. Large rock outcrops are numerous. A few stout lenses and irregularly-shaped bodies of quartz are visible, two of which at their widest parts are 8 and 12 feet wide, respectively. In addition, numerous quartz stringers characterize restricted areas. The quartz of the larger masses and of the veinlets does not appear to be mineralized and neither the larger quartz bodies nor the groups of veinlets are regularly orientated or aligned with the mine workings.

The dump from the main shaft consists largely of the granitic rock and sericite schist impregnated with ferruginous carbonate and quartz of various textures, with indefinitely defined platy inclusions of country rock rich in carbonate. There is also a white, sugary quartz different in appearance from most of the vein material and containing small segregations of chalcopyrite, pyrrhotite, galena, and pyrite.

A lens of chalcopyrite-bearing, sugary quartz in an outcrop of sericite schist and chlorite-carbonate schist lies 650 feet north 35 degrees east from shaft No. 2. It strikes northwest and dips 75 degrees to the northeast; both ends are concealed by drift. It has an average width of 10 feet for a length of 20 feet, beyond which to the northwest it narrows abruptly to 2 feet and continues for 20 feet in a direction which curves northward.

Vein material tested in this vicinity is reported to have assayed $18 per ton in gold.

Mr. Law of Banning reported discovering gold-bearing vein material visibly mineralized with chalcopyrite at a locality 650 feet south of Niven lake along the portage to Seine river near Banning. Two grab samples taken by him from this vicinity are said to have shown, upon assay, gold values at the rate of $28 and $33 per ton, respectively. At this locality mineralized quartz veins are visible in a small outcrop of hornblende schist. The schistosity strikes north 30 degrees west and dips 50 degrees west. Four veins, each pinching and swelling and having an average width of 5 inches, lie in a zone 10 feet wide and parallel the schistosity of the country rock. The veins are separated by intervals of 1 to 3 feet. They are 30 feet long with both ends clearly defined, but it is possible that other veins occur along their strike under the drift. Small parts of the veins are well mineralized with chalcopyrite and pyrite.

Large exposures of hornblende schist occur immediately east of the veins, but to the west there is a drift-filled valley, 300 feet wide, whose western wall is of granite-gneiss.

In Beaver lake 5 miles northeast of Banning station, on an island of granite with inclusions of chlorite schist and amphibolite, there is a nearly vertical quartz vein which strikes north 25 degrees west and maintains a width of 25 feet for a length of 500 feet across the whole breadth of the island. The southeast outcrop is cut at right angles by a lamprophyre dyke 10 feet wide. The average height of the outcrops of the vein is 20 feet above lake-level. The margins of the vein where exposed are not sharply defined because of inclusions of schist and the presence of quartz veinlets and tongues of silicified rock extending outwardly from the main quartz body. The vein was discovered some years ago by J. E. Marks of Port Arthur, who at one time owned the property on which it occurs. He reports that a number of samples taken across the entire width of the vein were found to contain gold, but the values were too low to warrant mining operations. The greater part of the vein where it has been stripped consists of white quartz which does not appear to be mineralized, but there are a few lenticular areas within which chalcopyrite and pyrite are visible. These mineralized areas are not sharply defined. The largest is approximately 2 feet wide and 20 feet long: a sample, weighing 1¾ pounds, taken by the writer across it over a width of 2 feet where it was well mineralized with chalcopyrite, was assayed at the Mines Branch, Ottawa, and found to contain:

Gold, 2·10 ozs. to the ton
Silver, 3·52 ozs. to the ton

In the writer's opinion further development work is warranted with a view toward determining the position and extent of ore-shoots in the vein.

Six hundred feet northeasterly and along the apparent strike of the vein, there is an islet, 125 feet in diameter, composed of syenite with inclusions of chlorite schist. Pyrite and pyrrhotite are disseminated through a large part of the rock and on the west shore there are two seams 1 foot wide and 4 feet apart, trending north 30 degrees east and dipping 30 degrees east, in which the rock is richly mineralized with these sulphides. The pyrite occurs partly in cubes; these include rock material and some of the cubes are half an inch in diameter. Mr. Marks reports that assays revealed the presence of low gold values in the mineralized rock. The greater part of the islet is drift-covered and the ore possibilities on it have not been fully investigated.

On mining location A L 195, at the southeastern end of Right Eye lake, a mass of coarsely crystalline vein quartz, with dimensions of 200 feet by 175 feet and a height of 30 feet, outcrops on a rocky knoll. Gneisses and various granitized schists occur in the vicinity. Small amounts of pyrite are locally disseminated through both the quartz and the country rock. No gold has been reported from this quartz mass. Its chief interest is its great size and the possibility that covered extensions may be ore-bearing.

There are abandoned mine workings on quartz veins at the east end of Eye lake and a quarter mile west of the northwestern extremity of Steeprock lake. Authentic information regarding the mineral content of the veins is lacking.

MOLYBDENITE

Small amounts of molybdenite were observed in pegmatite dykes cutting granite-gneiss at the following localities: the south shore of the narrows in Big Turtle lake; a small island in the northwestern part of the eastern expansion of Turtle lake about half a mile easterly from the strait; and an island between Turtle and Crowrock lake. At the last-mentioned locality the mineral occurs in sparsely disseminated scales half an inch in diameter; at the other localities the scales are very small.

BERYL

On an island in Turtle lake 2 miles east of its west end and near the headland of Portage bay, beryl was observed in a pegmatite dyke. The dyke is made up of quartz and microperthite showing graphic intergrowths, black and pale brown mica in flakes 1 inch in diameter, cherry red garnets, probably pyrope, in crystals $\frac{1}{10}$ inch in diameter, and unevenly distributed crystals of beryl. In an area of 4 square feet beryl crystals are abundant. They are translucent, of yellowish green colour and prismatic habit; some are 2 inches long and $\frac{1}{4}$ inch in diameter. No crystals of gem quality were observed.

SOAPSTONE

On the west shore of Buttermilk lake, 3 miles northeast of Banning station, there is a rectangular area, measuring about 400 feet on each side, underlain by a contorted, dark green, chlorite schist believed to be a highly altered, basic, pyroclastic rock. The schist is traversed by a few irregularly disposed aplite seams and lenses with an average width of 6 inches, which follow the bends in the schistosity for distances of a few feet and, in one case, scores of feet. The rock along the margins and beyond the terminations of these seams has been altered to grey soapstone and consists of talc with a small percentage of serpentine. The soapstone merges with both the aplite and the chlorite schist. The largest observed soapstone mass is 25 feet wide. It strikes northwesterly from the lake shore and may be safely assumed to have a length of at least 100 feet. Four other irregular, lenticular masses are partly exposed, with maximum known widths of 4 feet and lengths of 12 feet; and there are other small masses.

The soapstone occurrence is on unstaked Crown land and no development work has been done on it. The rock outcrops in this vicinity are sufficiently numerous to show that the dark green, soapstone-bearing schist is of restricted extent. Beyond where the soapstone occurs the schist is visible for only a few hundred feet south and in that direction no soapstone outcrops. Massive pillow lavas and pyroclastics of intermediate composition cut by pegmatite and aplite dykes outcrop around the area underlain by the dark green schist.

Fourteen hundred feet west of the north end of the bay at the outlet of Arnold lake, there is an outcrop of soapstone 4 feet in diameter. Its boundaries are concealed by a thin covering of drift, but no extension of the mass was observed in the numerous neighbouring rock outcrops. The rock assemblage is very similar to that at the previously mentioned soapstone occurrence, 4 miles to the west. The trend of the schistose rocks locally is north 20 degrees west.

ARGONAUT GOLD MINE, GAUTHIER TOWNSHIP, ONTARIO

By H. C. Cooke

In September, 1923, the writer made a detailed examination of the Argonaut mine, the results of which have been published.[1] During the summer of 1925 he extended the previous examination to cover the later developments. Mr. Thomas, manager of the property, and his staff gave the writer all possible assistance.

The developments since the writer's first visit are: (1) the stoping out of the ore found prior to that time; and (2) the extension of the underground workings in the search for new ore-bodies. In the latter work some 1,500 feet of drift and crosscut have been run on the 350-foot level; the 500-foot level has been extended north for nearly 500 feet, and other lateral work done; and a winze has been sunk from station 530 on the 500-foot level to the 625 and 750-foot levels where about 1,400 and 1,600 feet, respectively, of lateral work was done. At present the work being carried on is directed mainly toward the discovery of new ore-bodies.

The examination of the new workings has added a few facts to those previously obtained, has altered to some extent the previous conceptions of the geology, and has materially increased the information as to the origin of the ores.

The previous examination showed that the rocks around the mine are Keewatin lavas, basalts, and trachytes, intruded by dykes of quartz diorite and syenite porphyry. The two intrusives were not found in contact in the mine, but half a mile northeast of the shaft the syenite porphyry cuts quartz diorite and is chilled against it. The ores in places fill fissures in the syenite porphyry, and, therefore, were concluded to be later than both intrusives; they rose through fissures near a large dyke of quartz diorite. The basalt near the dyke was apparently highly heated by the dyke itself, and was altered by the heating and the solutions to a reddish product consisting of oligoclase-albite coloured by iron oxide. This was cut by numerous veinlets filled with high-temperature minerals such as magnetite and specularite, chalcopyrite, actinolite, pistacite, axinite, and oligoclase-albite, with some brownish quartz and red calcite.

It was also shown that the composition of the veins varies with their proximity to the heated zone near the dyke. Those within the heated zone consist mainly of magnetite and chalcopyrite, with more or less actinolite and pistacite. Where such veins pass out of the zone of red albitized rock near the dyke they are edged by rims of red albitized rock of varying widths, evidently formed by solutions emanating from the veins. A little farther away the country rock is not albitized, but red albite was deposited as the outer rim of the vein itself, and is accompanied by more or less red calcite. Still farther away, deposition of magnetite ceased and that of albite decreased, the red calcite changed to grey calcite, and

[1] Geol. Surv., Canada, Sum. Rept. 1923, pt. C I, pp. 42-60 (1924).

brownish or dark-coloured quartz came in larger amount. Still farther away quartz decreased and became whiter, and the proportion of white calcite increased. The amount of chalcopyrite also increased greatly, to form the solid lenses of ore that are mined. It was also shown that the individual lenses of ore rake toward the quartz diorite dyke, and accordingly become richer in magnetite with depth, exactly as the veins do laterally.

A very puzzling contradiction was noted in the previous report, that whereas good evidence was obtained that the quartz diorite was older than the syenite porphyry, and the ore younger than the porphyry, still the ore was related in space to a zone heated by a quartz diorite dyke. It seemed difficult to understand how the rock around the diorite dyke could have retained its heat throughout the long period of time represented by the intrusion and consolidation of the large masses of syenite porphyry; or, admitting that the heat was so retained, why the heated zones around the later syenite porphyries should not have been mineralized as well.

While studying the north end of the new 750-foot level near mine station 783, the writer was surprised by the discovery of a rock similar in appearance to the main quartz diorite dyke of the mine. The two are very similar in composition and grain, although the new rock is perhaps slightly more feldspathic. The surprise lay in the fact that this new body of intrusive is not bordered by a wide zone of red albitized country rock, like the main dyke of quartz diorite; nor is it characterized by a chilled edge 10 feet or more thick of hard, black, brittle glass, like the main dyke of quartz diorite. On the contrary the edge is extremely hard to find, as there is only about an inch thickness of slightly chilled material, and the country rock at this point is a rather granular basalt of much the same grain and composition. Still another point of difference between the main dyke of quartz diorite and this new body lies in the jointing. The main dyke is invariably characterized by two well-developed joint systems, one horizontal and the other vertical. The horizontal joints are much the stronger, and, spaced 4 to 6 inches apart, split the rock into a series of flat plates. The vertical joints are weaker and less continuous; so that the side of a drift in the main dyke looks much like a stone wall built of rather flat slabs. The new body of quartz diorite is not so jointed, but is fractured only by the rather irregular joints that also characterize the basalt.

Later, in the new workings at the north end of the 500-foot level, the writer encountered another mass of similar quartz diorite, penetrated over a much greater length by the workings. This mass lies comparatively close to the eastern edge of the main quartz diorite dyke, and, like the basalts in a similar position, has been largely altered to red material; so much so, indeed, that at first it was supposed to be the altered basalt, and its identity was only finally established by much tracing of altered into unaltered phases on the clean-washed walls, and later by microscopic examination of thin sections. In this locality also the locally reddened quartz diorite is cut by a small dyke of syenite porphyry, visible in three places.

It was shown in the previous report that the reddening of the country rocks was due to heating by the main dyke of quartz diorite and to the action of solutions rising through fissures in this heated zone; in other words, the alteration of the country rock and the formation of the veins must have followed very closely the extrusion of the dyke despite the fact that the veins are younger than the syenite porphyry and this in turn younger than the quartz diorite. The discovery of these other bodies of quartz diorite, their difference from the main dyke, and particularly the fact that they have been reddened like the other country rocks, point inevitably to the conclusion that instead of one quartz diorite in the area there are two, which on account of their strong petrographic resemblance have hitherto been confounded with each other. It is the earlier quartz diorite that forms most of the dykes of the area, and is undoubtedly older than the syenite porphyry; it has no wide chilled edge, has not reddened the country rock, and possesses no characteristic jointing. The quartz diorite forming the main dyke of the mine has these characteristics and must be a later intrusion.

Accepting this conclusion, there still remains unsolved the question of the relative ages of the later diorite and the syenite porphyry. Unfortunately the two cannot be seen in contact either on the surface nor as yet in the mine, but nevertheless there are two reasons for concluding that the later diorite is the younger. The first, an entirely negative reason, is that although there are several dykes of syenite porphyry throughout the mine, and the mine workings likewise penetrate considerable lengths of the quartz diorite, the porphyry nowhere cuts the diorite. The second is that, as shown in detail in the earlier paper, the ore-bearing solutions rose through a zone of country rock heated by the diorite dyke, and were deposited in fissures leading away from it. Some of these fissures containing ore cut the syenite porphyry in the southern ends of the 200- and 350-foot levels, so that the porphyry was clearly formed before the ore, and, therefore, also before the later quartz diorite.

Another feature brought out by the recent examination is the fuller recognition of the strength of the latest and main fault of the mine. This fault has produced a belt of highly sheared material 1 to 10 feet wide. In the lower levels it follows closely the western edge of the dyke of later quartz diorite, cutting into it in places, as toward the south ends of the 625- and 750-foot levels, and, therefore, has the same dip and strike as the dyke. About the 200-foot level, however, the dip of the fault appears to change from almost vertical to steeply east, and the fault leaves the dyke. The movement along this fault has been almost horizontal. There is no place in the mine where it can be directly measured, but on the 350- and 500-foot levels the position of the main dyke of syenite porphyry is well established by drill holes and lateral workings over a distance of more than 1,000 feet. The maps show a large displacement of the dyke in the middle of this distance where the fault passes, in ground yet unexplored, and the projections of the known boundaries into this area indicate a displacement of 100 to 150 feet. The movement is a left-hand one, that is, to an observer standing on one side of the fault and looking across it the opposite side has moved toward the left.

In the former report (page 59) reference is made to a whitish alteration of the basalt to carbonate that was found in a few places. Little could be learned of it, except that it had evidently taken place before the formation of the copper-bearing veins, since the latter cut through such altered material. In the new workings at the north ends of the 5th, 6th, and 7th levels large volumes of rocks thus altered have been cut, and a better opportunity for studying them thus afforded.

A belt of this altered rock 25 to 75 feet wide has been traced for 550 feet in the north end of the 750-foot level, striking north 30 degrees east, and with a vertical or steep dip. The highly altered material in the middle of the belt is a rather soft massive rock much like an unaltered limestone, varying in colour from creamy white to pinkish-white. Harder phases, also light-coloured, occur in a few places. The soft material is composed mainly of calcite and sericite, with a few grains of quartz, and the harder varieties differ only in containing a larger percentage of quartz. One specimen was taken in which quartz composes over 70 per cent of the thin section. These altered materials are cut by thin veinlets of calcite and quartz, and at the edges of the altered zone such veinlets run outward into the normal greenish basalts and are bordered by rims of whitish material, the colour of which fades gradually into the green of the lavas. Evidently, therefore, the whitish alteration product is formed by the leakage of the vein-forming solutions from the fissures into the enclosing rock. The alteration consists in the elimination of chlorite from the basalt, together with such fragments of feldspar as might have been present when the veins were formed; and their replacement by calcite, sericite, or paragonite, and some quartz.

There is no direct evidence of the origin of the solutions causing this alteration. The facts that the alteration occurred before the cupriferous veins were formed, that the altered rocks are not related in their distribution to the dykes of syenite porphyry, and that they are found only in the north end of the mine where the older quartz diorite also occurs, suggest that the alteration may have been caused by solutions emanating from the cooling masses of older quartz diorite.

The result of this season's work, therefore, has been to clear up the main unsolved problems of ore genesis at the Argonaut mine, and to prove that the auriferous copper ores are genetically connected with the intrusion of the later quartz diorite. The dyke itself did not give rise to the ores, but it did heat the rocks through which it ascended and thus render it possible for the hot ore-bearing solutions to rise to their present level before being cooled sufficiently to precipitate their contents. Moreover, the rapidity with which the solutions followed the intrusion of the dyke, before cooling of the dyke was complete, points to the conclusion that they originated in the same reservoir of fluid magma from which the dyke itself was extruded.

SUMMARY

The succession of events occurring at the Argonaut mine, as determined in the light of the two summer's work, is, therefore, as follows:

(1) Intrusion of dykes of the earlier quartz diorite into the folded Keewatin lavas. Probably followed by solutions altering the lavas to whitish mixtures of calcite, sericite, and quartz.

(2) Compressive stresses, producing joints striking north 20 to 60 degrees east and dipping 60 to 75 degrees northwest.

(3) Intrusion of dykes of syenite porphyry along some of the joint-planes.

(4) Intrusion of the large dyke of later quartz diorite, striking nearly north and with a practically vertical dip.

(5) Ascent of hot ore-bearing solutions, mainly through the zone of rocks heated by the quartz diorite dyke. The solutions altered the heated rock to albite, coloured red, presumably, by iron oxide; they deposited in fissures, first magnetite, then hornblende and pistacite, together with minor amounts of tourmaline, axinite, quartz, red calcite, and chalcopyrite. The remaining parts of the vein-forming solutions escaped through joint-planes and deposited their contents in the colder rocks farther from the dyke. The veins so formed consisted first of red calcite and albite, then of grey calcite and quartz, and at last mainly of calcite. Chalcopyrite containing high gold values was deposited in all stages, but most heavily in the last two.

(6) Formation of small faults, most of which strike north 70 degrees west, a few north 30 to 40 degrees west. Nearly all are right-hand faults, i.e., the north side moved east. They are filled with coarsely crystalline yellowish or pinkish calcite, quartz, and a little scattered chalcopyrite.

(7) Jointing, producing fissures that strike north 45 to 65 degrees east and dip steeply northwest. They are filled with slightly yellowish calcite and a little quartz, but sulphide is absent.

(8) Strong faulting, forming a great number of faults that vary in strike from north 60 degrees east to south 55 degrees east, and dip either north or south. In most instances the north side moved east, i.e., the faults are right-hand; and the movements are largely horizontal. The observed displacements are of all sizes up to 14 feet.

(9) Strong faulting, producing the major through-going fault of the mine bordering the west side of the later quartz diorite dyke, and many concomitant fractures. In the main movement the west side moved south 100 to 150 feet, and the displacement was largely horizontal, i.e., the fault was a left-hand movement; but many of the associated faults exhibit right-hand displacements.

(10) A single east-west fault is found in the south ends of the 200- and 350-foot levels, with a left-hand displacement of about 10 feet. It may be a branch of the main fault (9).

FURTHER DEVELOPMENTS AT LARDER LAKE, ONTARIO

By H. C. Cooke

The results of a detailed examination, made in 1923, of the new ore-bodies discovered at Larder Lake on the claims of the Crown Reserve Mining Company and the Canadian Associated Goldfields have been published.[1] During the past summer further time was given to study of the same properties, to determine the behaviour of the ore-bodies at greater depth.

In the two years up to August, 1925, the Associated Goldfields sank their main shaft from 500 to 1,000 feet in depth, and did more than 1,000 feet of lateral work on each of the 750- and 1,000-foot levels. During the same period the Crown Reserve Mining Company devoted their attention mainly to the development of the 525-foot and higher levels; but an inclined winze was also sunk some 250 feet from the 525-foot level, and short drifts run off at 125 to 250 feet.

The previous report showed that the Crown Reserve and Associated Goldfields Companies are operating on a single, good-sized lens of ore. The eastern half of the lens lies on the Crown Reserve property, the western half on that of the Associated Goldfields. The lens has its greatest width, 40 feet, on the 235-foot level of the Goldfields mine, close to the boundary between the two properties. The width gradually decreases to the west and the lens pinches out entirely about 550 feet west of the point of greatest width. It was forecast in the last report that the lens would probably extend eastward a similar distance, a forecast that the later work on the Crown Reserve property has since proved true. Smaller lenses of ore are found here and there along the strike of the main lens at varying distances from it.

The ore varies from red to grey in colour, and consists largely of quartz and calcite rather heavily mineralized with pyrite and arsenopyrite. The gold values mainly accompany the arsenopyrite, although the pyrite is also slightly auriferous. Some oligoclase is present in places, and hematite occurs in the red ore, undoubtedly accounting for its colour.

The country rock consists of Keewatin altered basalts interbanded with thin-bedded tuffs, and it was shown that the ore has been formed by replacement of the altered basalt by vein minerals. The proofs of the replacement, and the different reactions that took place during the process, were described in some detail, and will not be repeated here. It was concluded that the rocks were fractured by some early faulting movement, and through these fractures rose hot solutions that altered and replaced the country rock to form the present ore-body. Red ore was formed where the solutions were hottest, grey ore where they were somewhat cooler.

[1] Cooke, H. C.: Geol. Surv., Canada, Sum. Rept. 1923, pt. C I, pp. 61-73 (1924).

The ore is cut by a number of small faults and by one large one known as the " graphite fault " because of the amount of graphite developed in it. The graphite fault parallels the ore-body closely, but excellent evidence was obtained and is stated in the earlier report, showing that the fault is later than the ore. Still further evidence to the same effect was obtained during the summer between mine stations 705 and 708 on the 750-foot level of the Associated Goldfields mine, where fragments of ore varying in size from a few inches to many feet in length lie within the zone of shearing.

The outstanding feature from a mining standpoint is that the graphite fault changes its dip at a depth of about 725 feet from the 60 degrees south maintained in the upper levels to 45 degrees south between the 750- and 1,000-foot levels. As a result, the ore-body, which apparently maintains its dip of 60 to 65 degrees south, is cut off entirely at about the 750-foot level and has not so far been re-located. If the graphite fault is a thrust, as the evidence appears to indicate, the ore, which lies on the hanging-wall of the fault in the higher levels, may be found on the foot-wall at some greater but yet unknown depth.

The evidence previously obtained that the graphite fault is a thrust or reversed fault, i.e., that the south side went up relative to the north side, was rather indecisive, but the later mining operations lend strength to the conclusion. If the fault had been of the normal type, so that the south or upper side moved downward, the part of the ore-body beneath the fault-plane should be found as a second vein or lens parallel to the known vein and north of it; and as the dip of fault is but slightly less than that of the vein, there should be no great distance between the two bands of ore thus produced. Thus, considering the average dip of the fault as 60 degrees, and that of the vein as 70 degrees, 1,000 feet of differential movement should be required to put an horizontal distance of 192 feet between the two bands of ore. There is on the average less than 10 degrees difference between the dip of the fault and that of the vein, so that the two bands should be correspondingly closer together. Now the shaft on the 750-foot level is 410 feet from the vein and fault; on the 1,000-foot level it is 590 feet from the fault. As no band of ore is found in the crosscut on either level, it must be concluded either that the differential movement was at least 3,250 feet, or that the fault was not a normal one. As the fault hardly appears to be of such dimensions, it seems necessary to conclude that it is not a normal but a thrust movement.

While carrying on underground exploration on the 1,000-foot level the Associated Goldfields discovered in the western section of the level some new bodies of replacement ore. This ore is somewhat like the grey ore of the higher levels, but commonly somewhat darker in colour owing to less perfect replacement. The unreplaced rock is interbanded with thin-bedded tuffs, and is a rather dark grey rock that may have been either a thin lava flow or a rather thick bed of tuff. It consists of chlorite and a mica, sericite or paragonite, with some calcite, and many remnants of original feldspar. This material is cut by veinlets of quartz and calcite, and each veinlet is bordered by lighter grey, altered material that fades imperceptibly into the country rock. The solutions forming the veins are thus evidently the cause of the alteration. Under the microscope it is seen that the alteration consists of the replacement of the original minerals of the rock by quartz and calcite, together with some albite and pyrite. The chlorite is the first to disappear; the sericite persists in greater or less quantity until alteration is extreme. No great amount of albite is present, and what there is may have been formed merely by the recrystallization of the albite-oligoclase originally present in the rock, rather than by addition of material from the vein-forming solutions.

This ore, therefore, differs from the grey ore of the upper levels in containing no arsenopyrite, so far as observation shows, and in having no tendency to pass into red ore. Also, the replacement of the country rock is commonly less complete than in the upper levels and the ore is consequently a darker grey owing to the presence of more or less chlorite.

The drift running south 55 degrees west from the crosscut to the shaft, passes through two of these ore-bodies: one at 215-225 feet from the crosscut to the shaft, the other at 267-302 feet. They strike north 5 degrees east, and dip 65 to 70 degrees east. The first has a width of about 7 feet, the second of about 30 feet where cut by the drift. The ore assays from $10 to $25 per ton, according to the mine records.

The cause of the localization of the ore is suggested by observations made in the western end of the 750-foot level. Two small bodies of replacement ore are found on this level, one at mine station 723, the other between stations 718 and 722. The former is a small lens about 15 feet long and 5 feet wide, the latter a somewhat larger body about 35 feet long and 18 feet wide. It was noted that both these lenses occur at places where the tuff beds have been sharply bent. At station 723 the strike of the bedding changes sharply from about north 50 degrees east to north 10 degrees east, and the lens of ore is developed in the bend. At station 718 the beds are bent back, from due north to due east, and again the lens is developed at the bend. Apparently the sharp folding caused sufficient shattering or separation of the strata to permit of ingress of solutions to form a lens-like or pipe-like mass of ore. Where the beds straighten out once more solutions did not enter, and the lens accordingly ends.

The structure on the 1,000-foot level is such as to suggest a similar origin for the ore-bodies. The ore-bodies, with the tuff beds, strike north 5 degrees east where the drift cuts them, but the beds to the east strike north 55 degrees east. The change of strike occurs suddenly some 10 to 15 feet east of the first ore-body. It seems likely, therefore, that these ore-bodies will be found to be larger lenses or pipes of character similar to the small ones observed on the 750-foot level.

WRIGHT MINE, DUHAMEL TOWNSHIP, QUEBEC

By H. C. Cooke

Illustration

The Wright silver-lead mine is on the east shore of lake Timiskaming, approximately one-quarter mile south of the boundary between Duhamel and Guigues townships. It is readily reached by boat from Haileybury, 6½ miles on the other side of the lake; or by road from either North Timiskaming on the north or Ville Marie on the south.

The property is of unusual interest as being the first mineral deposit to be found in northern Canada. It was located initially on March 24, 1686, by a party of French explorers under the command of the Sieur de Troyes, and its location is shown on an early French map published in 1744.[1] The following interesting account of its history was written by J. A. McRae and published in the Cobalt Daily Nugget for 1921, and in the Canadian Mining Journal, issue of August 19, 1921.

"In the National Library of Paris are some notes which deal with the discovery of lead ore in 1686 upon the eastern shore of what is now known as lake Timiskaming. These notes were taken from the diary of Sieur de Troyes, and are referred to as "Relations and Journal of a Journey to the North by a Detachment of One Hundred Men Under the Command of 'Le sieur de Troyes,' in date of March, 1686."

"Thus it was that at a time when a few venturesome souls, some of them perhaps with nothing short of an empire in their brains and some of them merely the coureurs des bois of a new continent, were engaged in the difficult task of establishing the white race in North America, an ore deposit was discovered, only to be lost, then found again after the sway of the Indian tribes had become dissipated before the advance of civilization in Canada.

Names of Officers of the Detachment in 1686

Chaplain—Rev. Father Silvie, Jesuite
Commander—Sieur de Troyes
Lieutenant—Sieur de St. Hélène
2nd Lieutenant—Sieur de Hyberville
Major—Sieur de Maricourt
Assistant Major—Sieur de La Noue
Board Commissioner—Sieur Lallement
(Also designed to command a vessel in case we should not locate one to come to Quebecq).
Captain of the Guides—Sieur de St. Germain

Narrowly Missed Altering Tide of Progress in North America

"It is perhaps one of the strangest chapters in Canadian history that while attention has turned to the mineral possibilities of the country as far back as 1686, following this discovery on the eastern shore of lake Timiskaming, yet within three miles of the western shore of the same body of water the fabulously rich silver veins of the Cobalt district actually lay bleaching in the sun until accidentally found in 1903.

[1] Reproduced in Ont. Bureau of Mines, Ann. Rept., vol. XVI, pt. 2, p. 5½.

"Just here, it is interesting to indulge in conjecture as to what influence the discovery of these vast riches in native silver might have had upon early settlement on the North American continent. It seems quite safe to assume that had Cobalt been found in 1686, the attention of the Old World would have been focused with great intensity upon this region. It is not unreasonable to suppose that the tide of immigration to North America would have been in this particular direction. It is probable that bitter jealousies would have grown in the breasts of those who were blazing the western trails for France and those who were steering the destiny of Anglo-Saxon influence in the New World.

"It is one of the marvels of the opening of northern Canada that for more than two centuries white men, armed with all the inquisitive instinct of the race, should have trekked along lake Timiskaming, camped upon its shores, and failed to receive any intimation from their fellows or from the natives of the rich silver veins lying in the very shadow of their camps.

"But, to turn again to the history and romance of the Wright mine: The following are notes as taken from the Commander's diary, dating from May 12 to May 24, 1686, the date on which the lead deposit was found.

The Diary of Sieur de Troyes

"On May 12th. . . We reached 'Mattawan', which signifies in Indian language "Fork of Rivers": one being at a point that the left is to the south, and the road of Ottawa's to the right, which is north. Consequently my road leads me to Temiskamingue. I arrived at this place of Mattawan very early; this gave an opportunity to the Rev. Father Sylvie to celebrate Holy Mass. We were at a point where the Indians were camped, and were making canoes. They seemed to be greatly surprised to see such a lot of people. It had snowed in the morning, but the evening was very nice: I had dined with Sieur Juchereau that came from Michilmakina, and was going to Quebecq in great hurry to bring news to Monsieur le Marquis de Denonville. He had arrived as I was having dinner, and continued his journey shortly afterwards, to gain time on his route. In the same time I ordered Sieur de St. Hélène with three of our canoes to go and meet Mr. d'Hyberville.

"On May 13th. . . It rained, snowed, and strong wind all day; also continued the next day till noon. Monsieur d'Hyberville arrived and told me he had uselessly waited for two days for the canoe I had made him wait for.

"I was very suspicious of the Indians; consequently in order to keep my staff on the watch, I had ordered that nobody on the guard should sleep, and on the first alarm they were to put out a small fire, and in one word everybody was ready and in order, the arm in hand.

"I got a cross erected on the point of the Fork, and our English interpreter opened his leg to the bone with a stroke of the axe. We count from the island of Montreal to Mattawan one hundred leagues (or 250 miles).

"On May 15th. . . We could not start before sunrise on account of portaging we had to do in water which was extremely cold. We left after Mass was celebrated, and having made three portages, we camped one league higher than the first, and three and one-half from Mattawan. One of our canoes was broken in pieces in the second portage. Having landed in a rapid, we saved the contents, but we got some of the staff hurt. I got in the canoe of the Captain of our Guides, an Indian that knew the road of the 'Bay' perfectly well. I hired him in Mattawan.

"On May 16th. . . We were camped eight leagues from Mattawan, one league above the fourth portage. The road is very bad and for three hundred feet long, Sieur de Ste. Hélène was dragging.

"On the 17th. . . We went up again and the place that we name "The Long of the Soo". It is two leagues long and is extremely difficult on account of its great current. We had to pole it nearly all the way, and dragged it in five or six different places. We got some canoes damaged and we camped above the last rapid.

"On the 18th. . . We left in the morning, and left although there was a big storm that lasted very well near all day. Arrived at the house of Messrs. The Company of the North. This company is on an island of lake Temiskamingue: it may have one-half a league of circumference and between two rapids proceeding from a little river called "Matabec Chouan" in Indian, from which some Indians come out to trade. There were fourteen Frenchmen in this house for the Company that were as joyful as we were of our arrival, that we celebrated from parts and others by several shots of guns.

"On the 19th. . . And the two following days, the weather was very unfavourable, Messieurs de Ste. Hélène and d'Hyberville employed with Monsieur de St. Germain business of the Old and New Company, and furs that were in the store, where they appointed Sieur Sibille to render accounts of all to the company. We left him four men to make the trade with very little provisions. Sieurs Guillet and Villedieu stayed for three days at Nipissingue, Savage Nation, to get canoes made and to bring them to Montreal. As for us, we traded with the Indians that were close to our house to replace the ones we had, and that we had left there on account of them being too large and too heavy for the balance of our journey. I was very careful to put two good canoe-men for every canoe in order to jump the rapids.

"On the 22nd. . . It rained a part of the day; this did not stop us from going after celebration of Mass, followed by three canoes to go and visit a mine at six leagues from the house. I gave orders to Sieur de Ste. Hélène that I left, to settle the affairs and to join me the next day with the balance of the staff, and to keep in the Lake the route of the North, to facilitate his joining me. Two leagues from the house, I met three Indian camps that traded a small canoe of four places with me, that I made use of the balance of my journey and for my route to Quebecq. I camped from there on an island: weather not permitting me to go farther.

"On May 23rd. . . After Mass we walked to search the mine. The man named Coignac guided us. We met in our search an Indian camp in which the people the previous day had killed a big moose. This gave me an opportunity to camp close to them, and in order that Coignac would find the mine easier. He looked for it uselessly the balance of the day: during this time the two lieutenants left the house to join me with all our staff, but a big storm separated them; ones took the south and others took the north. One part got on islands, this was the cause of very few joining me.

"On May 24th. . . A very heavy wind all day accompanied by rain: but Coignac that had renewed his memory assured me that he recognized himself and that the mine was very close. I got in canoe with him: I paddling in bow and he steered and did not quit our search, although the weather was very bad, to go to the place where Coignac thought the mine was. We found it; indeed this mine is situated to the east and west on the borders of the lake, west of a rock in form of a half circle that has fifty feet on the edge of the water, ten feet high from the level of the water, and one hundred feet deep, having no earth on it and losing itself under a mountain covered with rock. We extracted a few small pieces with great difficulty and returned to the camp.

Time of the Re-Discovery

"There are no illustrations or drawings in existence which deal with the mine as it appeared more than two centuries ago. Indeed there is but meagre mention made of the deposit until about 1850. It was about this date that Mr. E. V. Wright of Ottawa, who owned the timber in this locality, rediscovered the deposit.

"Wright was engaged in removing timber from his concession when the calks on his boots chipped off some of the galena and lead-bearing ore. Samples of the ore were taken to Ottawa where they lay for several years on the desk of the discoverer. About 1870, it occurred to Wright to have the samples assayed. The result of the assay was such as to arouse considerable interest. Shortly after this, Mr. Wright, accompanied by J. M. Courier and Mr. Eustis from Boston, came up and commenced work sinking a shaft to a depth of about 12 feet. From this shaft they took out about ten tons of ore. Details of the result are lacking. It is recorded, however, that a second shipment was made by raft, but the crude conveyance smashed up in a mad plunge through the rapids at Deux Rivières.

"Nothing was done until 1885, when George Goodwin, of Ottawa, together with G. P. Brophy, advanced sufficient money to pay for sinking the shaft a farther 50 feet in depth as well as installing some mechanical equipment and a five-ton stamp mill. This plant was afterwards burned. No ore was shipped as a result of this work.

"About 1890, Robert Chapin, at that time president of the Ingersoll Rock Drill Company (N.Y.), bought the property and made an option payment on the basis of $125,000. He installed the first air compressor in the country, and built a fifty or sixty-ton mill. He continued the shaft to a depth of 250 feet and did considerable lateral work. This resulted in the shipment of a considerable quantity of concentrates, the value of which seems to be impossible to ascertain at this date. It is said that Mr. Chapin became involved in some bad investments which caused him to abandon this mining project with the result that the property reverted to Wright, the principal holder.

"In 1895, Wright sold the property to the Petroleum Oil Trust of London, England. The new owners sunk the shaft another 50 feet in depth and did several hundred feet of drifting and crosscutting at the bottom level, as well as some work at the 250-foot level. The mill was also operated, the concentrates being shipped to Swansea, Wales. No figures are available as to the amount of concentrates produced.

"The mill and buildings as erected by the Petroleum Oil Trust are still standing, although the machinery has been pretty well all removed. The writer visited the mine, June 18, 1921, together with the members of the Ontario Mining Association who were being entertained by the Timiskaming Mine Managers' Association. . . . These buildings are of the old-fashioned type, features being the many gables as well as having a ground floor entrance and a second storey entrance by stairways leading from the ground.

"A few years ago, the Wright mine was bought by the Timmins-McMartin interests of Montreal, and is still owned by them. The underground workings are filled with water, the plant is completely dismantled, and the visitor finds difficulty in throwing off a feeling of peculiar sadness as he views this neglected strange link between Canada of the present day and that wild land of 235 years ago, long before Wolfe took Quebec, and even dating back nearly a year before La Salle, the greatest perhaps of the French pioneers to North America. It was in 1682 that history tells us that in the name of France, La Salle took possession of all Louisiana, from the mouth of the Ohio to the gulf of Mexico, in a resounding proclamation handed down to us. On the column was inscribed "Louis de Grand, Roy de France et de Navarre, regne; le neuvième Avril, 1682." It was just four years later that the Wright mine was found, thus linking itself with a past about which only a little is known and which occupies but a dim place in the minds of men."

The surface geology around the mine has been studied by Barlow,[1] Miller,[2] and M. E. Wilson,[3] but none of these observers was able to examine the underground working, as the mine had not been worked for many years, and the workings were consequently filled with water. The owners decided to have the mine unwatered in the summer of 1925, in order to sample the property and explore it further with the diamond drill, and the present writer was thus afforded an opportunity to make an underground examination. He wishes to extend his thanks to Mr. D. Loughran, who was in charge of the operations, for assistance cordially extended to him.

The rocks in the immediate neighbourhood of the mine consist wholly of conglomerate of the Cobalt series. About a mile southeast there is a high hill of flat-bedded quartzite and arkose that may belong either to the Gowganda or Lorraine formations of the Cobalt series. About one-quarter mile south of the mine, flat-lying Palæozoic limestones outcrop on the lake

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[1] Barlow, A. E.: "Geology of the Nipissing and Temiskaming Map-sheets"; Geol. Surv., Canada, Ann. Rept., vol. X, pt. I, pp. 147-149 (1899).

[2] Miller, W. G.: "The Cobalt-Nickel Arsenides and Silver Deposits of Temiskaming"; Ont. Bureau of Mines Rept., 1905, pt. 2, p. 24.

[3] Wilson, M. E.: "Geology of an Area Adjoining the East Side of Lake Temiskaming"; Geol. Surv., Canada, Pub. No. 1064, p. 39 (1910).

"Temiskaming County, Quebec"; Geol. Surv., Canada, Mem. 103, pp. 146, 152-3 (1918).

shore. The Cobalt conglomerate appears to be, in its lower parts at least, a true basal conglomerate formed almost entirely of material derived from the rocks immediately underlying. This rock is an ordinary rather acid rhyolite such as may be found in many places in the Keewatin series, made up of rather numerous phenocrysts of white feldspar up to 2 or 3 mm. long, and many smaller phenocrysts of quartz, embedded in a fine-grained greyish matrix. The higher beds of conglomerate in a 40-foot cliff some 200 feet back from the shore, exhibit a more normal assortment of pebbles. The conglomerate extends downward the full depth of the mine shaft, 330 feet, and the conglomerate hill behind rises more than 120 feet above the collar of the shaft, as determined by levelling roughly with a Brunton compass; so that the conglomerate is more than 450 feet thick. The pebbles of the conglomorate both within the ore-body and outside of it are all very well rounded.

In view of the historical interest of the property and the fact that it is unlikely to be re-opened for examination for some time to come, it seems desirable to describe it in somewhat more detail than its value would perhaps warrant.

The ore is a breccia made up of fragments of Cobalt conglomerate cemented together by coarse-grained white calcite, galena, and zinc blende. It outcrops on the shore of the lake, the outcrop being bounded on the inshore side by non-brecciated conglomerate. Between the outcrop and the shaft 20 feet inland, the surface is covered with the loose materials of the dump, but the shaft enters the southeast edge of the ore-body, so that the mass of non-brecciated conglomerate between the shaft and the ore on the shore is evidently a horse.

The shaft reaches a depth of 330 feet and levels have been run at depths of 50, 100, 179, 230, and 330 feet. The workings on the different levels are shown in Figure 1, together with the outlines of the ore-body as observed and conjectured.

It will be observed from the plans of the different levels that the ore-body is an almost vertical pipe broadly oval in cross-section; and, further, that this pipe is largest in diameter between the 100 and 179-foot levels. The limits of the ore-body are those of the brecciated zone.

No cause could be found accounting for the formation of a body of breccia of such extraordinary shape. A pipe of this sort might be formed at the junction of two faults, but no evidence of pre-ore faulting on a large scale could be discovered. There are a few small faults around the edges of the ore-body at which the mineral veinlets stop abruptly, but nothing that would seem likely to account for so extensive a brecciation. It is to be noted, however, that the introduction of the ore into the conglomerate must have been accompanied by a considerable increase in the volume of the whole, since there is no evidence that the ore has replaced any of the conglomerate; and the pressures thus produced were probably relieved by upward movement, since relief of pressure would be possible only in this direction. Under such conditions it is possible that there may have been originally in the conglomerate only a few comparatively small cracks that were filled with ore; and that the upward movements resulting from the

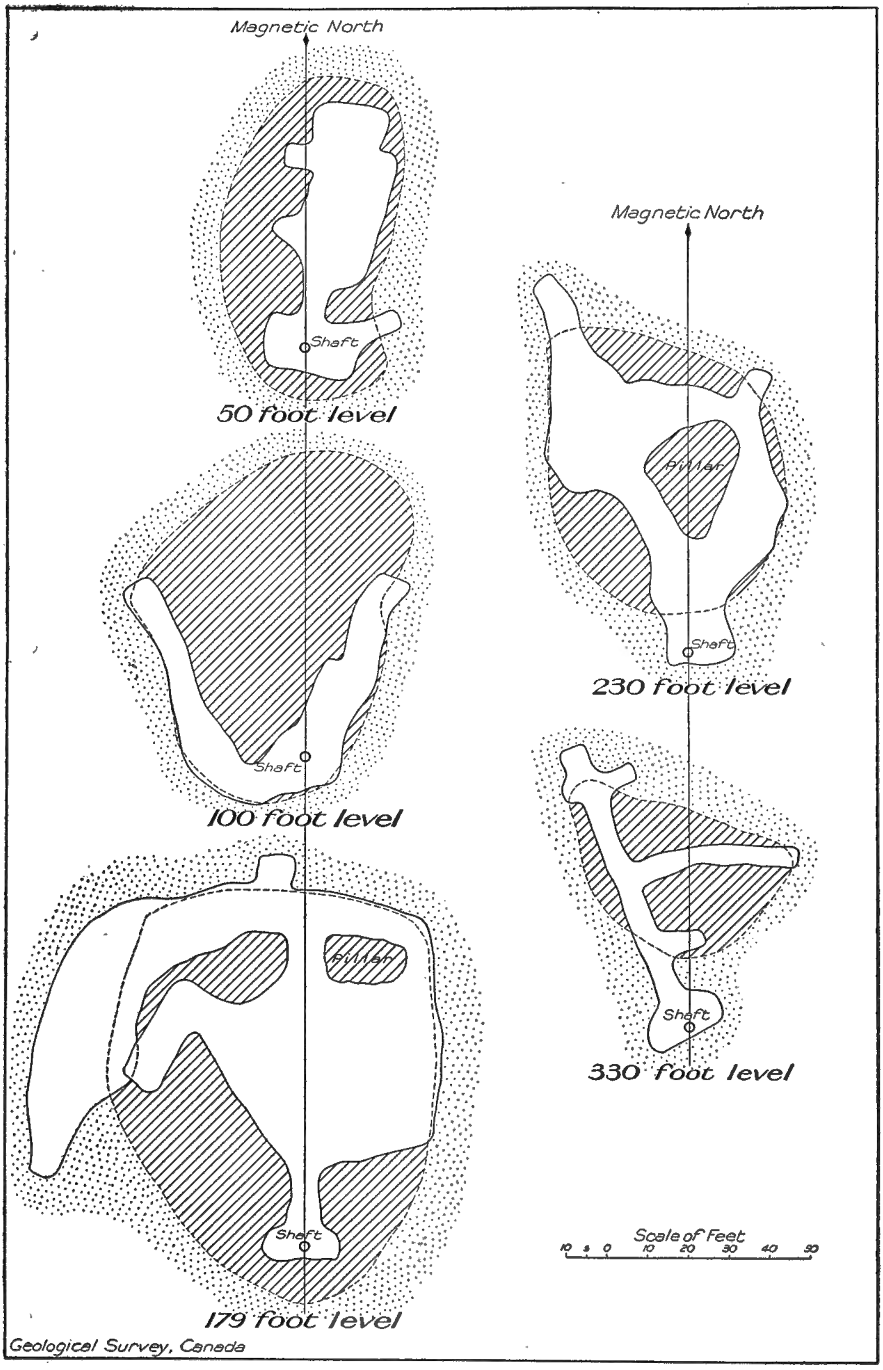

Figure 1. Plans of levels, Wright mine, Duhamel township, Quebec. Country rock indicated by pattern of dots, ore still remaining by pattern of diagonal lines. (Except where crossed by workings, the position of boundary of ore-body is inferred.)

pressures developed by crystallization caused further brecciation. Under this conception the greater part of the brecciation would be contemporaneous with the ore deposition rather than of earlier date.

If this theory be true, the stresses forcing the rocks upward as crystallization proceeded might be expected also to cause some rupture of the walls of the deposit, with formation of horizontal open fissures. Such fissures are in fact rather numerous in the mine, and are of all sizes up to a foot in width. They are now filled mainly with quartz, which, as it is found in the mine only in these fissures, is evidently a later vein filling. The quartz is accompanied by galena, sphalerite, and calcite, all of which might have been, and probably were, taken into solution from the deposit by the solutions carrying the quartz and later deposited in the open horizontal fissures. These fissures contain numerous open vugs, and pass from the edges of the ore deposit into the unbrecciated country rock.

The ore has a rather definite vertical variation. At the surface and on the two upper levels the ore is very largely argentiferous galena with very little sphalerite. The proportion of sphalerite increases downward to the 179-foot level, where it is largest. Below the 179-foot level both sulphides decrease in quantity. An occasional grain of pyrite is to be found throughout the mine, but more of it occurs in the 330-foot level than elsewhere.

The results of several hundred assays made when the mine was sampled about eight years ago, were placed at the writer's disposal; but as the location of only a few of these was indicated on the mine maps and it is evident from the character of the underground workings that practically all samples must have been taken within the ore-body, it was considered best to average them by levels in the hope of arriving at some conception of the changes taking place with depth. The results obtained are as follows:

Level	Silver	Lead	Zinc
	Oz. per ton	Per cent	Per cent
50-foot	1·72	9·62	None
100-foot	0·63	0·2	0·8
179-foot	0·86	3·16	1·63
230-foot	1·1	2·25	0·95
330-foot	0·36	0·36	0·77

The results show certain interesting regularities. If the values for the 100-foot level be omitted from consideration, the results become even more regular. It seems justifiable to omit the averages of the values obtained on the 100-foot level, as the workings on that level are comparatively small and closely follow the edges of the ore-body where the proportion of ore to rock is invariably low. So far as could be seen during the examination, the ore on the side of the drift toward the middle of the ore-body is of much the same grade as that in the levels above and below. The lead values decrease downwards with great uniformity. The silver values decrease to a minimum at 330 feet depth, though not with the uniformity of the lead. Zinc on the other hand increases from zero at the 50-foot level to a maximum at the 179-foot level, then decreases downward.

Another point of interest is the entire lack of correspondence between the silver values and the amounts present either of galena or of galena and sphalerite combined. This lack of correspondence between the amounts of silver and of sulphides present is equally obvious on scanning the individual assays from which the above averages were derived. The wide variations in the proportions of silver to sulphide render it obvious that no uniform relationship exists between them. It may reasonably be inferred, therefore, that the silver is not present in solid solution in the sulphides, but more probably is mixed with it irregularly in the form of one of the silver sulphides.

All available facts point to the conclusion that the deposit was formed by descending meteoric waters rather than by hot, ascending solutions. The cause of the precipitation, and the reason for the concentration at this particular spot are as yet unknown. The difference in the behaviour of the lead and zinc sulphides is one commonly found in deposits of character similar to this, and is due to the greater solubility of zinc compounds, causing them to be carried somewhat farther before precipitation takes place. The source of the ores is, therefore, to be sought in the rocks formerly overlying the present deposit. As flat-lying Ordovician limestones overlie the Cobalt series within short distances to the south, west, and north, it may reasonably be assumed that they overlay the area around the mine also, and have since been eroded away. How the lead-zinc minerals came to be present in the Palæozoic rocks can be only a matter of speculation.

GOLD AND COPPER DEPOSITS OF WESTERN QUEBEC

By H. C. Cooke

CONTENTS

Illustrations

INTRODUCTION

The writer during 1925 continued the examination, begun in 1923,[1] of the mineral deposits of western Quebec; the work consisting of the study of important properties discovered since 1923, and of the re-examination of older properties where mining operations had made new data obtainable. For the warm welcome and cordial hospitality everywhere extended to him and his party by mining men the writer expresses his sincere appreciation. Without exception the officers of the different properties facilitated his work in every way and placed all their information at his disposal, as well as making him personally welcome. In particular he wishes to thank Mr. A. A. Mackay of the Pioneer Exploration Syndicate, Messrs. W. B. Lawson, Davies, and J. C. Carroll of the Huronian Belt Mining Company, Mr. L. K. Fletcher of the Noranda Mines, Mr. Carl Erickson of the Amulet Gold Mines, and Mr. J. Drybrough of the Victoria Syndicate.

INTRODUCTION

The various rocks of the area and their age relations so far as known are summarized in the following table taken from the writer's former report,[2] with two minor changes.

Table of Formations

Quaternary	Post-Glacial Glacial	Clays, silts, sands Boulder clay, stony and gravelly morainic deposits
Huronian	Cobalt series	Conglomerate, greywacke, arkose, argillite

[1] Cooke, H. C.: Geol. Surv., Canada, Sum. Rept. 1923, pt. C I, pp. 76-125 (1924).
[2] Geol. Surv., Canada, Sum. Rept. 1922, pt. D, p. 28 (1923).

Great unconformity

Pre-Huronian......	Pre-Huronian intrusives........	Basaltic diabase Later Gabbro Hornblende-mica lamprophyre Syenite porphyry Granite
		Folding
		Diorite porphyry Diorite (Older Gabbro) Hornblende lamprophyre
	Timiskaming series............	Conglomerates, greywackes, basalts
	Unconformity	
	Keewatin......................	Basalts, andesites, dacites, rhyolites, and tuffs

The principal change in the above table is in the rock known as the Older Gabbro. In the report for 1923 the writer described a basic intrusive occurring on Opasatika lake which, following M. E. Wilson, he termed amphibolite. This rock forms sills in the Timiskaming series and has been differentiated in place, so that its composition varies from a coarse, rather feldspathic mixture of hornblende, biotite, and feldspar in the upper parts of a sill to a basic type carrying 80 or 85 per cent of hornblende in the lower parts. The differentiation having occurred in place, indicates that the sill was intruded while the Timiskaming series was still flat, *i.e.*, before the period of folding indicated in the above table. In the same report a number of intrusives of very similar composition were described under the name of Older Gabbro. It was pointed out that the latter are confined, rather peculiarly, to the Keewatin areas, and it was suggested that they might be identical with the rock described as amphibolite. However, as the Older Gabbro appeared to form dykes rather than sills and did not appear to be differentiated, it was tentatively placed as later than the period of folding.

Since 1922 the writer has found several places where the Older Gabbro in the Keewatin areas exhibits differentiation in place, two of the most noteworthy being the mass northeast of Labyrinth lake and some masses south of lake La Motte (Malartic).[1] There can be no doubt, therefore, that the Older Gabbro was intruded before the folding period instead of later, as at first supposed; and this, coupled with its petrographic similarity to the rock called amphibolite in 1922, makes it likely that the two belong to the same period of intrusion.

Accordingly the two rocks are now grouped under a single name, in the position formerly occupied by the amphibolite, i.e., after the deposition of the Timiskaming series but prior to its folding. As both the amphibolite and the Older Gabbro are true diorites, composed mainly of plagioclase and hornblende rather than plagioclase and augite, it also seems best to replace the earlier, incorrect names by the correct one, " diorite."

[1] Cooke, H. C.: "Some Gold Deposits of Western Quebec"; Geol. Surv., Canada, Sum. Rept. 1923, pt. C I, p. 102 (1924).

In the report for 1922 rock that forms dykes cutting the syenite porphyry south of Renaud lake, was described as syenite. In 1923 it was discovered[1], that both the syenite and the syenite porphyry are merely phases of the same rock magma, which northeast of Renaud lake outcrops in a large mass differentiated into a great variety of types. The term syenite has, therefore, been eliminated from the table of formations.

DETAILED DESCRIPTIONS OF CLAIMS

"RUSSIAN KID" CLAIMS

In October, 1924, A. W. Balzimer and Mike Mitto staked a group of thirty-three 40-acre claims on the northeast side of Labyrinth lake, Dasserat township. Balzimer later made a discovery of gold on claim T 2108 that created much interest. Since that time the partners have done much work both in opening up this discovery and in prospecting the remaining claims. The vein has been exposed by cross-trenching for a length of about 350 feet, and a number of shallow pits have been sunk on it, one about 12 feet deep. At the west end the vein pinches out, but a quarter mile beyond this point and on the projected strike of the vein, a pit was sunk in the drift, and ore was found at bedrock; so that there is evidently another expansion of the vein in this direction, though little is yet known of it.

The vein follows closely the contact between a body of granite and one of the diorite, cutting here into the one, there into the other, rock. It strikes north 70 degrees east, and dips 75 degrees south. At the easternmost exposure, where it disappears beneath a swamp, it is 7 feet wide. About 200 feet west the width lessens to 2 feet, then increases again to 5 feet 70 feet farther on, finally decreasing to zero about 350 feet from the eastern exposure.

The vein matter consists of white quartz and a little iron carbonate very heavily mineralized with coarse-grained pyrite. The wall-rock is also rather heavily mineralized with pyrites for distances of 1 to 3 feet from the vein. The pyrite apparently carries the gold. A sample consisting of about 80 per cent pure pyrite, taken by the writer, assayed $9.60 in gold per ton. The average tenor of the vein matter, excluding free gold, is $6 to $7 per ton according to the owners, and that of the heavily mineralized wall-rock $3 to $4 per ton.

Much free gold was found in the vein when it was first opened up, giving the discovery a highly spectacular character. The free gold has been found, up to the present, only in the limonitic material formed by weathering of the pyrite; it seems probable, therefore, that the free gold is merely residual, and will not be found in unweathered vein material. Accordingly, it seems unlikely that the average tenor of the vein materials will exceed the values quoted.

The rock on the north side of the vein is a large sill of the diorite, differentiated in place so that the southern or upper side is much more highly feldspathic than the northern or lower part. On the south

[1] Op. cit., p. 122.

side of the vein there is a good-sized body of a granite so similar in its general texture and appearance to the more acid phases of the diorite as to suggest that it is a differentiate of the diorite magma. It is made up of about 30 per cent or more of free quartz, 5 per cent of hornblende in long needles, now largely altered to chlorite, 2 or 3 per cent of magnetite in coarse crystals, and the remainder mainly oligoclase, $Ab_{80}An_{20}$. Unfortunately, time did not permit of a more extended study of these interesting rocks.

The rock along the granite-diorite contact is rather highly sheared, either by faulting or by slip between the two formations during folding.

ARNTFIELD AND FRANCOEUR CLAIMS

The Arntfield claims, which lie about 1½ miles northwest of Renaud lake, Boischatel township, were staked by F. S. Arntfield in October, 1923. The group includes eleven claims with a total area of 1,860 acres. Veins of potential value have been found on the F. S. Arntfield and Joe Baker claims, Nos. T 298 and T 450, respectively, followed fairly closely by a base-line that strikes about north 80 degrees west. The Francoeur claim, belonging to the Pioneer Syndicate, adjoins the Joe Baker claim on the west, and the ore-body on it lies on the westward projection of the same base-line. It is not yet known whether this line follows the general strike of a fracture zone filled with a vein or series of veins, or whether, as seems more probable, the veins are a series of lenses striking about east and west, and chancing to be crossed by this base-line.

The country rock of the claims is mainly Keewatin lava of about the composition of trachyte, but varying slightly to both more basic and more siliceous varieties. Near the east side of claim T 298 and 4 or 5 chains south of the base-line, there is also exposed a thick bed of coarse rhyolite breccia or agglomerate. The strike of the flows is nearly due east and west, the dip steeply northward, and the upper surfaces of the flows face toward the south. A few small dykes of syenite porphyry and gabbro cut the flows, usually nearly parallel to their strike.

The ore-bodies are all replacements of the country rock by quartz, carbonates, and other minerals. The replacement seems to have occurred mainly at the contact of two flows, perhaps because the upper surface of a flow is more readily replaced than any other part by reason of its fine-grained texture, or perhaps because the slipping of one flow on another during folding created a zone of fracture or shear through which solutions flowed readily. Whatever the reason, however, these contacts appear favourable to the localization of replacement ore-bodies, and consequently the dip and strike of the ore-bodies is controlled by the structure of the flows, and is parallel to it.

Three bodies of ore have been found, one at the east side of the F. S. Arntfield claim, T 298, one at the west side and extending across the line into the Joe Baker claim, and a third on the Francoeur claim near the east side. All these bodies, as previously mentioned, are close to a base-line run north 79° 55′ west from the east line of T 298 from a point 150 feet south of post No. 1.

The easternmost ore-body has been traced for some 300 feet by trenching the north slope of a low, rocky hill. The drift is up to 6 feet in depth, and becomes deeper to the east and west, so that the vein has not been traced farther. The best exposures are in trenches 750 to 800 feet along the base-line from the east boundary of the claim. Here the exposed width of the ore-body is nearly 30 feet, and the north contact is still hidden beneath drift. The ore is a very fine-grained, light grey rock liberally sprinkled with very fine-grained pyrites, and weathering to a reddish-brown. This material, which is much altered country rock, is traversed by ill-defined and discontinuous bands of lighter grey or white material, which appear to be vein material. The microscope shows that they consist largely of calcite, with a little quartz, pyrite, and a few grains of clear, fresh albite. The least replaced material between the veins is largely sericite with badly altered fragments of the original feldspar of the rock, albite or oligoclase albite; in other parts of the thin sections the replacement of this sericite-albite mixture by the carbonate and pyrite of the veinlets may be observed in all its stages. The average tenor of the replacement ore on the surface is $7 per ton in gold.

There are two rather interesting occurrences near this vein which, although not of economic importance, appear to throw some light on the origin of the ore-bodies. About 115 feet south of the vein a dyke of feldspar porphyry, 4 feet wide, runs east and west, and dips about 70 degrees north. It has been traced in the trenches for a distance of 250 feet. The porphyry is a coarse-grained reddish rock, composed of stout crystals of albite up to an inch in length in a finer-grained albite groundmass. It is cut by numerous veins of quartz up to a foot in width, and very irregular in shape, that run across it at various angles. Particularly interesting is the fact that the veins are practically confined to the dyke; only two or three were observed to cut across the contact and extend into the wall-rock, and those that do so continue only for short distances, a few inches or a foot or two, before ending. The vein material, though largely quartz, also includes some ferruginous carbonate and some coarse pyrite. A sample of the pyrite, freed as well as possible from quartz, assayed $10.60 in gold per ton.

The porphyry is partly altered to carbonate, a thin section showing the presence of 25 to 30 per cent of that mineral. The wall-rock on each side of the dyke for distances of more than 20 feet is similarly altered, and converted into a fine-grained, reddish rock very like the material of the ore-body, but more thinly sprinkled with pyrite. Under the microscope the replacement is seen to be like that of the ore-body, but less complete; the feldspar-sericite mixture composing the country rock is only about one-third replaced by carbonate, and there is no albite in the veinlets as there is in the ore-body. Assays of the altered rock on each side of the dyke yield gold values of 40 cents to $2 per ton.

Between the dyke and the ore-body, about 8 feet south of the latter, there is a vein of white, glassy quartz, ferruginous carbonate, and pyrite, identical in appearance with the veins in the porphyry dyke. The vein is about a foot wide, strikes north 65 degrees west, and dips almost vertically. The country rock on each side is altered to carbonate like that on each side of the porphyry dyke, and, like it, carries low values in gold.

Some 800 feet farther west, or 1,500 feet from the east boundary of the claim, measured along the base-line, another small porphyry dyke is found. It lies 75 feet north of the base-line, strikes due east and west, and has been traced nearly 300 feet by trenching. This dyke is not cut by quartz veins, but is bordered by bands of partly carbonated rock. These are only 3 or 4 feet wide, however, instead of 20 to 25 feet.

These observations, therefore, bring out a very suggestive group of facts: (1) The ore consists of the country rock largely altered to carbonate and fine-grained pyrite, and the veinlets causing the alteration contain albite as well as quartz and calcite. The presence of the albite and the completeness of the alteration of the country rock indicate that the vein-forming solutions were hot. (2) A similar alteration, but one much less complete and accompanied by much less deposition of pyrite and gold has been caused by veins of quartz and iron carbonate, without albite. The lack of albite and the decreased intensity of alteration point to solutions like those forming the ore, but cooler. (3) The occurrence of the quartz veins in the porphyry dyke shows that the veins and alterations are somewhat younger than the porphyry intrusion. (4) The presence of the altered bands on each side of the porphyry dykes suggests some connexion between the porphyry and the alteration. It may be that the alteration was caused by solutions given off by the dykes on cooling, but the small size of the dykes coupled with the large quantity of altered rock is against this conclusion. It is difficult to conceive that so small a volume of normal igneous rock could have held in solution the large amounts of carbonate and, presumably, water necessary to complete this alteration. Also, other quite similar porphyry dykes in the neighbourhood are not bounded with bands of altered rock. It is probable, therefore, that these particular dykes were injected into some zone, such as the belt of schist between two flows, through which ore-bearing solutions could also penetrate; so that the altered zones are not associated with the dykes because the dykes cause alteration, but because both alteration and dyke intrusion were conditioned and localized by a common cause.

It will be observed that the whole association of facts here is very similar to that observed at Matachewan,[1] although the sequence of events is not so completely displayed as at Matachewan. In both places the country rocks have been replaced very largely by calcite and mineralized with fine-grained auriferous pyrite. In both places the most extreme alteration and highest mineralization are caused by pegmatite veins, made up of quartz and albite as well as calcite. In both places cooler solutions emanating from quartz veins without albite have caused alteration to carbonate with little mineralization.

It was definitely proved that the ore-bodies at Matachewan were deposited from solutions that emanated from a large body of syenite por-

[1] Cooke, H. C.: "Geology of Matachewan District, Northern Ontario"; Geol. Surv., Canada, Mem. 115, pp. 49-56 (1919).

phyry during its cooling. No such proof of the origin of the Arntfield ore-body has yet been worked out. However, the presence of a very large body of syenite porphyry only a mile northwest of the Arntfield, and the likeness of the Arntfield occurrence to that at Matachewan, suggest rather strongly that these ores likewise originated from the porphyry.

The second ore-body is at the west end of the F. S. Arntfield claim, T 298, extending west into the Joe Baker claim. It has been traced for some 400 feet, and runs into low ground at both ends. The known eastern extremity of this body is 200 feet south of the base-line and 3,000 feet from the eastern side of the claim. The stretch of swamp east of it is 850 feet wide, and in a trench just beyond the swamp, or 2,150 feet from the east side of the claim, there have been discovered some bands of similarly altered rock that may possibly represent the eastern end of the ore-body. The ore-body has a maximum width of more than 50 feet 3,000 feet from the east end of the base-line, and narrows on the west to 6 or 7 feet. In the wide part the tenor averages $8 per ton in gold, throughout an 8-foot section.

The third ore-body lies near the east side of the Francoeur claim. It crosses the base-line about 4,300 feet from its eastern end, and has been traced west about 250 feet. Like the others it has the shape of a lens, 22 feet across at the widest part. The gold values vary from $7 to $9 per ton.

The second and third ore-bodies are so similar in their essential features that they can be described together. Like the first they are replacements of the country rock, but unlike the first the prevailing colour of the ore is red, though grey phases also occur. In fact the ore both in hand specimen and under the microscope is closely similar to the ore found in the Crown Reserve and Associated Goldfields mines at Larder Lake.

The country rock is a trachyte composed where freshest of phenocrysts of albite-oligoclase, $Ab_{90}An_{10}$ up to 1·3 mm. in length, embedded in a finer-grained matrix of the same mineral. Somewhat more basic varieties carry 3 or 4 per cent of chlorite, probably secondary after hornblende, and 2 or 3 per cent of fine-grained ilmenite. Types as fresh as this are rare, however, and found only where the glassy, upper parts of flows have been preserved unsheared. Almost everywhere the feldspar of the lavas has been largely replaced by secondary mica which forms half or even more than half of a thin section.

Around the edges of the ore-bodies the course of alteration and ore deposition can be readily observed. The unaltered trachyte is sliced by numerous small joints, most of which run east and west parallel to the main trend, and the remainder ramify in every direction. Through these fissures the ore-bearing solutions evidently travelled, depositing minerals in them and altering the country rock on each side. As a result the grey country rock is now traversed by numerous, narrow, reddish bands, each with a hair-line veinlet at the centre. The individual bands average perhaps one-fortieth to one-eighth inch in width, and their colour fades rapidly at the irregularly-outlined edges into the colour of the country rock. Much wider bands are formed by the coalescence of two or more bands where they approach or cross one another. The larger ore-bodies are formed merely by the coalescence of a large number of such altered bands.

The composition of the central veinlets varies a good deal. Some consist almost wholly of fresh, clear albite, muscovite, much pyrite, and a little hematite and calcite; the rock on each side of these is intensely reddened due to the presence of a very fine reddish dust, too fine for microscopic determination, but which is probably hematite, judging from the colour and the presence in the vein and the rock of a few larger crystals that are undoubtedly hematite. In addition to the red mineral a little calcite and some pyrite have been introduced into the rock, but on the whole it is not highly altered. The composition of the feldspar of these veinlets varies from $Ab_{80}An_{20}$ to $Ab_{90}An_{10}$.

The veinlets described are found in the 2,160-foot trench (i.e. the trench opposite a point on the base-line 2,160 feet from the east end) and of all the veinlets examined most nearly approach the composition of igneous rock. Among the thousands of other veinlets all gradations of composition may be found from that described down to almost pure calcite. In general, however, they may be subdivided into three other main types, those containing no mica, but some albite accompanied by quartz and calcite; those containing quartz and calcite, but neither mica nor albite; and those containing calcite, with or without a little quartz.

The veins composed of albite, quartz, and calcite commonly also carry auriferous pyrite in considerable quantity and redden the rock on each side of the vein. In the altered and reddened band no chlorite is to be found, although much may be present in the adjacent unaltered lava, and iron has also been abstracted from the ilmenite crystals, leaving them represented by whitish patches of leucoxene. The sericite and albite of the rock are little affected if at all. Some calcite and pyrite, commonly not more than 3 or 4 per cent, have been introduced. Beyond the removal of the iron and the consequent change in colour, therefore, the rock has not been greatly altered in composition.

The veinlets carrying quartz and calcite in approximately equal proportions appear to have exercised the most powerful alterative effects. They have commonly reddened the wall-rocks on each side. Like the last, they removed chlorite and the iron of the ilmenite, and in addition attacked the sericite or paragonite, completely removing it in the neighbourhood of the veinlets. The veinlets carry a good deal of pyrite, and a considerable amount of the same mineral is introduced into the altered country rock. The further alteration of the country rock varies a good deal from place to place. In some instances the feldspar is either unchanged or is partly recrystallized; in others it is largely or wholly replaced by quartz, calcite, or a mixture of the two.

The fourth class of veinlets, those composed largely of calcite with or without a few grains of quartz, carry very little pyrite and have had practically no effect on the surrounding rock. Veinlets running about at right angles to the general trend were traced from the ore-body several feet out into the country rock. Close to the ore-body they had the quartz-calcite composition of the veins of the third class, and altered the wall-rocks accordingly; farther away the composition gradually changed to the calcite composition of the fourth class of veins, the alteration of the wall-rock gradually decreasing to zero accordingly. The calcite veins are, therefore, evidently deposited from the residues of the solutions that formed the quartz-calcite veins, and represent a later, lower temperature type of deposit.

The composition of the veins found in these ore deposits, therefore, indicates that the solutions depositing them varied from very hot and concentrated, almost igneous, in character, to cool and dilute. The veins might be arranged according to composition in a continuous series, each member of the series differing only slightly from the next. There can be little doubt, therefore, that they all have a common origin, and that the differences in composition are to be ascribed wholly to temperature differences. The presence at one end of the series of such minerals as hematite, albite, and mica is good evidence that the solutions were of juvenile origin. There are no facts definitely connecting them with any igneous mass in the vicinity, although the probability is that they arose from the mass of syenite porphyry to the north.

CLAIMS OF THE HURONIAN BELT MINING COMPANY

The claims of the Huronian Belt Mining Company are in Boischatel township close to the eastern boundary, and west of Pelletier creek. The property includes five claims with a total area of about 1,100 acres.

The principal gold discovery lies in the southeast corner of claim No. T 412. It is a lenticular body striking north 80 degrees west and dipping about 60 degrees north. It has a maximum width of about 8 feet, and up to the time of the writer's visit about the end of August, 1925, has been traced for some 350 feet without finding the east end. The work done at that time consisted of a number of cross-trenches and shallow pits, with one inclined shaft 29 feet deep. A 5-foot channel sample across the vein in this shaft assayed $15 per ton in gold.

The country rock consists of thin-bedded, fine-grained, altered tuffs interbanded with one or more thin flows of dacite lava. The latter is distinguished in places by a variolitic texture. The tuffs are made up of chlorite, leucoxene, calcite, sericite, and a little quartz, together with the remains of the original feldspar, oligoclase $Ab_{80}An_{20}$, which has been partly replaced by the calcite and sericite. The proportions of these minerals vary from bed to bed. The dacite consists of a few phenocrysts of quartz and oligoclase embedded in a flow-textured matrix of feldspar with a little chlorite, sericite, and leucoxene.

The ore, as on the Arntfield claims, is formed by the replacement of the country rock. The latter is cut by small veins and veinlets, on each side of which the rock is bleached and partly altered. The veinlets vary in composition much like those described on the Arntfield. One of the most pegmatitic consists of oligoclase, $Ab_{80}An_{20}$, and calcite in approximately equal proportions, with a little chlorite probably secondary after hornblende and a little garnet. Others are made up of quartz and calcite in about equal proportions, with or without a little feldspar, and there are many made up mainly of quartz with some ferruginous carbonate and a little hornblende, now altered to chlorite. All of these veins carry some pyrite. The country rock has not been as intensely altered as on the Arntfield property. Its chlorite is largely removed, and in places the sericite also, and accompanying these changes there seems to have been some recrystallization of the feldspar into fresher, somewhat larger individuals. A certain amount of calcite and pyrite have been introduced, but on the whole not a large amount. The sum of these changes has been to produce a rock somewhat lighter in colour than the country rock, and one rather liberally besprinkled with auriferous pyrite, but whose original composition is by no means utterly destroyed.

No evidence was obtained to suggest the possible origin of this ore-body. On the Bathurst claims a mile or two to the southeast, however, there are some large masses of syenite porphyry from which ore-bearing solutions of this type might be expected to come.

BATHURST CLAIMS

A brief visit was made to the Bathurst claims, lying southeast of the Huronian Belt claims near the west boundary of Rouyn township. No work was being done at the time, and accordingly no certain information as to the location of the best workings or the tenor of the ores could be obtained. However, Mr. J. F. Davies, of the Huronian Belt Mining Company, who had visited the property on a previous occasion, kindly volunteered to accompany the writer and point out the places where he believed the most work had been done.

One of these places is on the Edna Bathurst claim, T 371. Here a large mass of grey feldspar porphyry intrudes the greywackes and conglomerates of the Timiskaming series, and has been exposed by trenching in several places. The porphyry differs notably in composition from the common syenite porphyry of the district in that its ferromagnesian constituent is biotite rather than hornblende. The rock is composed of numerous white phenocrysts of oligoclase-albite, $Ab_{85}An_{15}$, up to an inch in length, embedded in a dark grey matrix of albite, biotite, and a little quartz. A good deal of zoisite is also present in small laths, forming perhaps 1 or 2 per cent of the rock. The grain of the matrix averages about 0·05 mm. in some varieties, in other varieties it attains 0·5 mm.

The feldspar porphyry is cut by numerous veins of dark-coloured glassy quartz up to a foot in width. Their courses are crooked and irregular, without any definable strike or dip. They carry on occasional grain of sulphide, and some free gold is said to have been found, although the writer saw none.

For a few inches on each side of these veins the porphyry is bleached and altered. Microscopic study shows that the biotite and zoisite have been entirely removed from the bleached zone, and a good deal of colourless mica with a little calcite have been introduced. The colourless mica is not merely the bleached remnants of the biotite, but is new mineral replacing the feldspar. A light sprinkling of pyrite and arsenopyrite also characterizes the altered zones.

About half a mile west of the locality described there is a large vein of quartz in the Timiskaming conglomerate. The schistosity of the conglomerate strikes north 85 degrees west, and dips 50 degrees north, and the vein parallels the schistosity fairly closely. It has been traced by trenching for 250 to 300 feet. In that distance it varies greatly in width, pinching down to a few inches and swelling again to a maximum of 6 feet. The vein material is a rather dark, glassy quartz that carries a good deal of free gold in one place. The country rock for a few inches on each side is heavily mineralized with arsenopyrite.

CHANCE CLAIMS

The Chance group of claims is in Boischatel township about a mile northeast of the Arntfield claims. The principal discovery lies near the northeast corner of the Howard claim, No. M.L. 1860 or block 18, some 50 feet north of the centre line of the township and 2½ miles east of its western boundary.

The country rocks at this point are light coloured, hard, glassy rhyolite lavas interbanded with beds of breccia. Two of the flows cut by the vein are respectively 60 and 80 feet thick; the three beds of breccia with which these flows are interbanded are 15, 32, and 18 feet thick, respectively. The beds strike north 62 degrees east and dip steeply north; and a very excellent determination was obtained, indicating the south sides of the flows to be the original tops. The rhyolite is made up of some phenocrysts of quartz embedded in a fine-grained matrix of fresh feldspar with a little actinolite. The feldspar has a low index of refraction, about that of albite or oligoclase-albite; but the exact determination is not possible in thin section, as the minerals are full of strain shadows.

Sulphides have replaced the rhyolites along a well-defined band or zone striking north 75 degrees west, and, therefore, cutting across the bedding at an angle of about 45 degrees. It would seem, therefore, that the replacement has taken place along some original straight-line fracture. Where the sulphide band cuts through a rhyolite flow it is 3 to 6 feet wide. Where it crosses a bed of breccia it swells into a great mass of solid sulphide 30 feet or more in width and partial replacement of the breccia has occurred for 100 to 200 feet farther.

The sulphide mass is composed almost wholly of pyrite, with some magnetite toward the edges. The writer's assistant, Mr. H. C. Gunning, states that some zinc blende has now been found, but none was visible at the time of the writer's visit. The pyrite is said to carry low gold values, but no definite information on this point was obtained, as work on the property was suspended when the property was examined.

The vein where it lies in massive rhyolite may be divided into two parts, a central zone of complete replacement, and two outer zones of partial replacement. The central zone, 3 to 6 feet wide, is a solid mass of fine-grained pyrite. The outer zones exhibit the rhyolite cut by numerous veinlets of solid pyrite, and a good deal of fine-grained magnetite and pyrite scattered sparsely through the rhyolite between veinlets. Beyond the zone of pyrite veinlets there is another zone of magnetite veinlets, the larger of which contain a central string of pyrite grains.

A thin section of the rhyolite carrying pyrite veinlets showed a narrow veinlet holding, in addition to pyrite and a little magnetite, an assortment of minerals characteristic of deposits from very hot solutions. These are quartz, a hornblende close to actinolite in composition, pistacite (epidote) in clean-cut primary crystals, and a good deal of a mineral, now altered beyond recognition, with the outlines of a feldspar.

The rhyolite breccias are some of them ash beds and some of them probably flow breccias. The one of which a thin section was made appears to be of the latter class. It consists of pebbles of glassy, light-coloured rhyolite up to a foot in length in a matrix of fine-grained, dark greenish, chloritic material. Under the microscope the matrix is seen to consist of needles of actinolite largely altered to chlorite, and a fine-grained feldspar near albite in composition, in about equal proportions. A few grains of quartz were also identified. The pebbles are a very quartzose rhyolite, like that already described.

Where the vein crosses the breccia it swells into great masses of massive pyrite 30 feet or more in width, through the complete replacement of both pebbles and matrix. Beyond the edges of this body of solid sulphide a selective replacement has occurred, the matrix of the breccia being completely or partly altered to pyrite, the pebbles left comparatively untouched, although a little sulphide may have been introduced into them also, particularly near the borders of the mass of solid sulphide. The microscope also shows that the introduction of pyrite into the matrix has been accompanied by that of a good deal of magnetite.

This sulphide deposit, although not commercially valuable except as a possible source of sulphur, nevertheless yields some data of importance. (1) It illustrates the type of deposit found in acid rhyolites, a point that will be further discussed when more sulphide deposits have been described. (2) The mineral assemblage is characteristic of deposits from very hot concentrated solutions. (3) The deposit exemplifies beautifully one way in which the wall-rock may influence the character of the deposit. In the massive, not easily replaced rhyolite the sulphide band is comparatively narrow, whereas in the easily replaced breccias it is of many times greater width.

AMULET GOLD MINES

The Amulet Gold Mines, Limited (120 St. James street, Montreal), has three groups of claims in the district, known respectively as the "A," "B," and "C" groups. The "A" group is that on which the principal discoveries have been made, and on which most of the development work has been concentrated. It comprises seventeen claims covering altogether about 1,500 acres of land astride the Dufresnoy-Duprat boundary, and between 1 and 2½ miles from the south boundary of these townships.

The first discovery was made on claim M.L. 1897 near the north end of the block, just west of the Duprat-Dufresnoy line about 2 miles from the south boundary of the township. The amount of ore at this spot is small. A much larger ore-body was found later near the east side of claim M.L. 1891, in Dufresnoy township about a mile from the south boundary and ¾ mile east of the Duprat-Dufresnoy line, and was thoroughly outlined by development. A third ore-body was located, late in September, 1925, about a half mile south of the first discovery, near the middle of claim M.L. 1889 and some 25 feet west of the Duprat-Dufresnoy line.

In addition to the development work on the three discoveries, careful and systematic exploration is being carried on throughout the other parts of the property. Lines have been run with a transit north-south and east-west, the lines of each set spaced 400 feet apart except over the discoveries, where they are 100 feet apart; and these lines are being carefully traversed by a geologist who maps the rock exposures and uses a dip-needle to detect possible bodies of ore beneath the drift-covered parts.

Although the ore-bodies so far discovered on the Amulet property are not large, their relations are of very great interest, furnishing a wealth of information as to the conditions that determine and limit the formation of such ores.

One most unusual feature is found in the structure of the Keewatin lavas which form the bulk of the country rocks. It was mentioned in a previous report[1] that the flows west of the middle of lake Dufault lie almost flat, a fact which, combined with the known dips to the north and south, shows that this area lies at the summit of a great anticline in the Keewatin series. The work of the past summer both verified the previous observations and added to them. A large number of flow contacts were discovered, all of which dip at very low angles, commonly less than 10 degrees. This area of flat-lying flows not only includes the whole of the Amulet property, extending south beyond the area examined, but also goes northward somewhat beyond the Waite-Montgomery discovery; so that it has a width from north to south of at least 3 miles. As the axis of the anticline strikes about north 60 degrees west, it is evident that the anticline is one with a very broad, flat top. Furthermore, it was found from a study of the space relations of the contacts that the surfaces of the lava flows when first formed were not flat or even approximately so, but possessed reliefs of 100 feet or more, much like the prevailing surfaces of today. A detailed description of these very interesting contacts is now in preparation, and will appear in the Transactions of the Royal Society of Canada for 1926.

The most widespread lava on the claims is a hard, glassy rhyolite, a thin slab of which emits a clear, ringing sound when struck with a hammer. It is rather light grey, fine-grained, very amygdaloidal, and finely porphyritic with very small phenocrysts of white feldspar. It is characterized by well-developed pillow structures in the upper horizons of the flow. The microscope shows it made up of 5 to 10 per cent of quartz, 2 or 3 per cent of magnetite in small grains, about 35 to 40 per cent of a very light-coloured actinolite, so light coloured that it approaches tremolite in its characteristics, and the remainder a feldspar. The feldspar forms narrow laths, pierced by numerous long needles of the actinolite. It was not possible to determine its composition with exactness on account of the presence of the actinolite

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[1] Cooke, H. C.: "Some Gold Deposits of Western Quebec"; Geol. Surv., Canada, Sum. Rept. 1923, pt. C I, p. 120. *Also,* "Progress of Structural Determination in the Archean Rocks of Ontario and Quebec"; Trans. Roy. Soc., Canada, 3rd ser., vol. XIX, sec. IV, p. 14 (1925).

and of a good deal of secondary alteration; but it is believed to be an oligoclase, near andesine in composition. The numerous amygdules are filled with mixtures of biotite and quartz, with an occasional grain of pyrite or magnetite.

Lying on the surface of this hard rhyolite flow are scattered patches of a more basic lava, the remnants of a once widespread flow now largely eroded away. With this rock the copper ore is invariably associated. It is a dark brownish-black, and its most prominent characteristic is the presence, in certain phases, of rounded, whitish nodules up to ¾ inch diameter embedded in the dark matrix. The weathered surface of this rock has thus a very striking spotted appearance (Plate I A), somewhat resembling the coat of the Dalmatian, or coach dog; and accordingly the rock has been christened dalmatianite by the miners. As the name appears suitable, it is hereby retained.

That the dalmatianite is a lava is clear from irrefutable evidence. The upper parts of the flow are highly amygdaloidal. Well-developed pillow structures characterize it in many places; and still other parts have the ropy or cordy textures always formed when a viscous lava has been forced to flow. Although it is a lava, and, therefore, had little or no opportunity for differentiation, it exhibits remarkable variations in composition. A specimen of the normal lava taken from the middle parts of the flow, dark grey in colour, massive, fine-grained, and without any unusual textures, consists of 75 to 80 per cent andesine feldspar, $Ab_{60}An_{40}$, with some 10 per cent of biotite, 10 per cent of quartz, and 2 or 3 per cent of fine-grained magnetite. The average grain is about 0·1 mm., but the quartz forms larger crystals up to 0·5 mm. in length; and there is a tendency for both quartz and biotite crystals to segregate into masses. In one or two places in the thin section there are vaguely-defined areas several millimetres in diameter, throughout which all the feldspar undergoes extinction at once, indicating that these areas are really single crystals of feldspar, though filled with inclusions of the quartz, biotite, and magnetite so as to be otherwise indistinguishable from the other parts of the rock.

The various tendencies shown in this massive central part are carried to extremes in other parts of the flow. The lower horizons, near the contacts with the underlying rhyolite, are apparently massive on a freshly broken surface, but the weathering shows that the texture is really corded and fragmental. These are best seen near the first discovery on claim M.L. 1897. In thin section the corded or fragmental structure is distinct, the fragments or cords having a much finer grain than the remainder of the rock. This material contains about twice as much biotite and twice as much quartz as the normal rock, and the feldspar is correspondingly reduced.

The uppermost parts of the flow, which may be seen at the discovery on claim M.L. 1891, are very fine-grained, and dull black, weathering to a rusty brown. They are highly amygdaloidal, the amygdules filled with quartz and some pyrite. Another specimen from a few feet deeper in the flow carried amygdules filled with biotite of most unusual pleochroism, varying from colourless to dark grey with a hint of green. The rock itself consists largely of ordinary brown biotite and quartz, with 2 or 3 per cent of magnetite. Much of the quartz, however, occurs in aggregations of lath-like shape, suggesting that it may have replaced crystals of feldspar. The biotite forms 70 to 75 per cent of the rock in these upper layers.

The bulk of the upper parts of the flow, below the highly amygdaloidal zone, is characterized by the extraordinary spotted texture from which the rock derives its name. These parts are made up of a rather fine-grained, blackish matrix, commonly somewhat amygdaloidal, enclosing numerous rounded, light grey nodules. The nodules are commonly not more than $\frac{1}{4}$ inch in diameter, but in one place on claim M.L. 1891, where the nodular texture is associated with pillow structure, the nodules attain diameters of $\frac{1}{2}$ to $\frac{3}{4}$ inch (Plate I A). Under the microscope the matrix is seen to have a composition much like the surface phases described in the preceding paragraph. Brown biotite is the principal constituent, forming about 75 per cent; the remainder is quartz, feldspar, and a little magnetite. The rather numerous amygdules are filled with quartz and brown biotite in about equal proportions, the biotite aggregated in a mass in the centre, the quartz forming a rim around it.

The nodules are much less basic in composition. In them biotite forms only about 2 per cent, and there is also some muscovite present, bringing the total mica up to 5 or 6 per cent. Quartz commonly constitutes a large proportion of the nodule, 20 to 25 per cent, although in one section there is as little as 3 per cent. Two or 3 per cent of magnetite is usually present, and the remainder consists of andesine feldspar, $Ab_{60}An_{40}$. The most interesting fact, however, is, as shown by the extinction, that all of the feldspar of each nodule forms one single crystal, in which are included all of the other minerals. In one thin section even amygdules were found to form inclusions in the nodules. The edges of the nodules are not clean-cut lines, but narrow bands in which the proportion of biotite increases rapidly outward until it becomes so large that the continuity of the feldspar crystal is lost.

In a few places on claim M.L. 1891 there may be seen small patches of a still later lava overlying the dalmatianite flow. This rock is amygdaloidal and contains well-developed pillow structures, so that the identification as a flow is indubitable. It is rather dark grey, weathering to a brownish grey, and its most outstanding characteristic is the presence on the weathered surface of numerous rounded protuberances, $\frac{1}{20}$ to $\frac{1}{8}$ inch in diameter, where small aggregates of hornblende have resisted weathering influences better than the body of the rock. It is composed of 50 to 60 per cent of actinolite, 2 or 3 per cent of magnetite, and the remainder a feldspar that appears to be andesine, although the thin section available was not good enough for a definite determination. The rock might, therefore, be termed an andesite.

In addition to these flows, the rocks are cut by a number of dykes and sills of both acid and basic types. Some of the dykes are undoubtedly the feeders of once overlying flows now entirely removed by erosion.

The sulphide bodies have been formed by the replacement of the upper parts of the dalmatianite lava flow by pyrite, pyrrhotite, zinc blende, and chalcopyrite. In places replacement has been complete, and solid masses of sulphide thereby formed. In other places replacement has been only partial, and the ores, therefore, consist of grains and nodules of sulphide disseminated throughout a matrix of rock. The limitation of replacement to the upper parts of the flow is probably due to a combination of three causes: (1) The upper parts are more basic than the lower, as already shown, and, therefore, more liable to replacement. This point will be discussed more fully in the later parts of this report. (2) The upper parts are finer in grain than the lower, and the minerals, therefore, offer a large surface to the attack of ore-bearing solutions. (3) The presumably greater porosity of the upper, highly amygdaloidal parts might have permitted a freer circulation of solutions through them.

Since, therefore, the sulphides have replaced the upper horizons of the dalmatianite lava, and the flows in this vicinity lie flat or have low dips, it follows that the ore-bodies must form almost flat sheets, with dips corresponding to the local dips of the flow. This conclusion has been fully confirmed by the study of the outlines of the ore-bodies and their behaviour in depth as determined by trenching and drilling. The maximum thickness of ore beneath the andesite cover, where, of course, none of the ore can have been removed by erosion, is about 40 feet; and from this maximum the thickness decreases to zero at the edges of the body where erosion has cut completely through the sheet of ore. The outcropping bodies are, in all probability, merely remnants of sheets of larger size. The northern discovery, on M.L. 1897, is a very small remnant; that on M.L. 1891 is a much larger one.

The sulphides are pyrite, chalcopyrite, pyrrhotite, and sphalerite or zinc blende. The pyrite and pyrrhotite were the first to be formed during the replacement, and probably the zinc blende also was deposited along with them, although this has not yet been determined with certainty because oxidation of the material in the trenches masks the relationships. Chalcopyrite was definitely formed, for the most part at least, at a slightly later date, as it may be seen cutting the earlier sulphides in small veinlets and replacing the pyrrhotite. In a few places there seems to be a tendency toward selective replacement by the sulphides, the zinc sulphide tending to replace the micaceous matrix of the dalmatianite, the other sulphides the nodules; and some beautiful specimens have been obtained reproducing the nodular texture in solid sulphide, the nodules composed of bright yellow pyrite or chalcopyrite, the matrix of darker brownish sphalerite. Such specimens are uncommon, however, and for the most part all the sulphides replace the groundmass of the dalmatianite more readily than the nodules, and the latter are only attacked as replacement approaches completeness.

The values of the ore are found mainly in their copper and zinc contents. Small values in gold, averaging between $1 and $2 per ton, and in silver up to 5 or 6 ounces per ton, are also present. The variation of the copper and zinc content is naturally large from place to place, depending on the proportion of country rock replaced and on the relative proportions of sphalerite and chalcopyrite.

WAITE-MONTGOMERY CLAIMS

The Waite-Montgomery property was staked in March, 1925, by J. H. C. Waite, C. H. Ackerman, and T. Montgomery. It includes two groups respectively of seventeen and twenty-eight, 40-acre claims in Duprat and Dufresnoy townships. The discovery is in the northwest corner of claim No. A 2864, the No. 1 post of which is on the Duprat-Dufresnoy line 20 chains south of mile-post IV, measuring from the south.

The ore-body underlies a muskeg that fills an east-west valley between rhyolite hills. The muskeg is 800 to 1,000 feet wide, with only a few isolated knobs of rock above its surface. It chanced that a tree in this muskeg was blown down by the wind and the moss and soil around it on its roots being lifted a patch of ore was revealed at almost the only spot where the ore approaches the surface closely enough to be thus exposed. Mr. Montgomery crossing the swamp noticed it, and the discovery was made.

The development work of 1925 up to the time of the writer's visit consisted entirely of trenching, and the presence of ore was thereby proved over an area roughly 100 feet from north to south and 200 feet from east to west, without reaching the edges of the body. All of this area is underlain by ore, and no contact with rock was found at any place. Early in October a diamond drill was brought in, and drilling has been carried on throughout the winter.

The ore at the surface is massive sulphide, with little or no included rock or gangue. The sulphides include pyrite, chalcopyrite, sphalerite, and some pyrrhotite. The average of thirty channel samples showed 17·3 per cent copper, 3·6 per cent zinc, 40 cents per ton in gold, and 2·8 ounces per ton in silver.

The examination of the lava flows immediately south and southwest of the discovery resulted in some excellent structure determinations. The best observation, obtained on a bed of breccia lying between flows, gave a strike of north 30 degrees west, dip 15 degrees northeast. This attitude, coupled with the known facts about the ore-body and about the relationship of the ore-bodies to the structure as determined on the Amulet, makes it reasonably certain that the Waite-Montgomery ore-body, also, is a comparatively flat sheet of ore.

HORNE CLAIMS

The Horne claims lie on the west side of Osisko lake (lake Tremoy) in the northwestern quarter of Rouyn township. The principal discoveries are on the Miller claim, block 15, where a rocky hill rises 150 feet above lake-level. Rock outcrop is fairly continuous over an area 1,700 feet from north to south, and 1,200 feet from east to west. To the east and south the surface flattens, and is covered by a blanket of clay; to the west the surface, although low and swampy, is diversified by scattered rocky knobs.

When the writer examined this property in 1923[1] only a small amount of trenching had been done, and the claims were almost entirely covered

[1] Geol. Surv., Canada, Sum. Rept. 1923, pt. C I, pp. 116-119 (1924).

with forest. In addition, the strong local variations of the compass made it difficult to locate points with accuracy without the use of a transit. Since that time the bush has been entirely cleared from the area of interest, and lines have been run with a transit north-south and east-west, at intervals of 200 feet. By traversing these lines, therefore, geological boundaries may be rapidly and precisely determined. The lines are numbered east and south from the northwest corner of the Miller claim, block 15, hereafter referred to as the zero point.

The development work of the last two years has consisted of diamond drilling and underground prospecting. The areas of possible interest were thoroughly explored by a network of drill holes, and two shafts were then sunk at points of greatest prospective importance. No. 1 shaft was sunk 1,300 feet east and 1,650 feet south of the zero point; shaft No. 2 is about 1,000 feet to the northwest, or 550 feet east and 900 feet south of the zero point. No. 1 shaft is 328 feet deep, and about 4,000 feet of lateral work, mainly at the first level, was completed from it up to March 1, 1926. The No. 2 shaft has been sunk to a depth of 158 feet, and some 800 feet of lateral work has been done.

Owing to various circumstances it was impossible for the writer to undertake a geological examination of the underground workings in 1925, and the work was accordingly restricted to making a study of the surface feature (*See* Figure 2).

The rocks consist of Keewatin volcanics intruded by dykes of three types and ages. The volcanics include rhyolite lavas and agglomerates, together with more basic flows which may be termed andesites. The intrusive rocks include the older gabbro, or diorite, the later gabbro, and a syenite porphyry.

The rhyolite lavas are light grey, massive rocks weathering almost white. They carry small phenocrysts of quartz and feldspar up to 1 mm. in diameter, embedded in a fine-grained matrix consisting mainly of oligoclase, $Ab_{85}An_{15}$, with more or less chlorite and a little quartz. The agglomerates are coarsely fragmental beds of rhyolite ash. In them fragments of rhyolite of all sizes are cemented together by a paste of finer particles. A general subequality of size seems to prevail, however, among the larger fragments of the individual beds. Thus, one bed will occur in which fragments 3 to 4 inches in diameter are numerous, whereas in an adjoining bed no fragment more than an inch in diameter will occur.

Some beds of very fine-grained cherty tuffs also occur, particularly on the east side of the area, 1,700 to 1,800 feet east of the zero north-south line. These tuffs are very glassy and light coloured, in places translucent with a slight greenish tinge, and some parts contain as much as 70 per cent of quartz, the remainder of the rock being mainly sericite secondary after feldspar. Such a composition is probably due to silicification of an original fine-grained ash.

The andesites are easily distinguished from the rhyolites as the weathered surface is greenish rather than light grey. They exhibit pillow structures in places. Chlorite composes about half of these rocks, and the remainder is mainly feldspar badly altered to such products as kaolin, sericite, epidote, and carbonate.

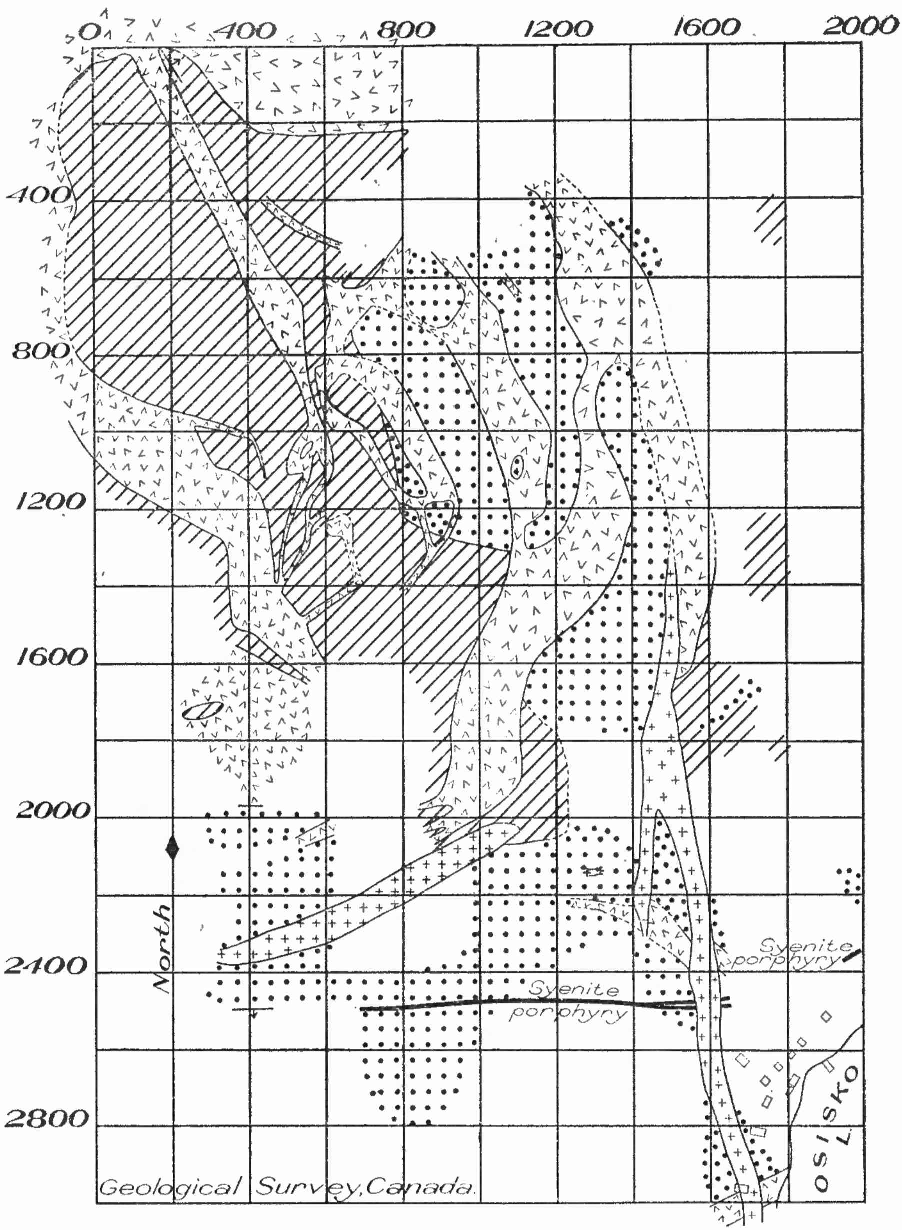

Figure 2. Geology of part of Horne mineral claims, Rouyn township, Quebec. Andesite indicated by dots; rhyolite lava and tuff by diagonal ruling, earlier gabbro by angles; syenite porphyry by solid black; later gabbro by crosses; drift-covered areas left blank; grid shows surveyed lines 200 feet apart.

The structure of the lavas is of great interest. On the Brownlee claim, about 1,000 feet north of the boundary of the Miller claim, an excellent structure determination yielded the data: strike north 85 degrees east, dip vertical, upper side of flows faces toward south. On the southern part of the Horne area the structure is similar. About 2,500 feet south and 400 feet east of the zero point a good determination yielded: strike due east, dip steep or vertical, top to south. Again, at 2,050 feet south and 1,250 feet east of the zero point, the strike is north 80 degrees east.

Between the northern limit of outcrop, practically the north line of the Horne claim, and a line 2,000 feet south of it, the structure is not east and west, however. At a point 200 feet east and 20 feet south of the zero point a very good determination yields: strike north 30 degrees west, dip steep or vertical, top to east. Between 700 and 800 feet east of the zero point, and 900 to 1,200 feet south of it, a boundary between andesite and rhyolite may be traced, swinging in strike from north 25 degrees west at the north end to north 15 degrees west at the south end.

It is evident from these facts and also from the general areal arrangement of the lavas that the Horne area, like the Chadbourne area to the west, is one where there has been violent drag-folding, caused undoubtedly by the slipping of the lava flows upon one another during formation of the great anticline whose crest is 3 or 4 miles to the north.

As drag-folding is a phenomenon that must by its very nature affect a belt of rocks much longer than wide; and as such a belt must be parallel or nearly so to the general strike, it seems, therefore, that if two places where drag-folding has occurred are approximately on a line parallel with the general strike, it is reasonable to conclude that two such areas of drag-folding are parts of one drag-folded belt. The Horne area includes a drag-folded belt more than 2,000 feet wide from north to south. The Chadbourne ore-body, only about a mile to the west, is a similarly drag-folded area about 500 feet wide. It is possible that the two areas are parts of separate belts of drag-folding, striking about east-west, and each drift covered except at one locality. It is also possible that the two areas may be parts of a single belt of drag-folding which in that case would strike north 65 degrees east, and widen, cone-like, toward the east. At present there are no data to indicate which alternative is correct.

The oldest of the intrusive rocks is also that present in largest volume. It is a diorite forming large and irregular dyke-like masses, and it is mainly confined to the drag-folded belt.

The rock is now largely altered to chlorite and other secondary products, so that its original constituents can only be inferred from the appearance of clean weathered surfaces to have been a feldspar and hornblende in about equal proportions, with a little ilmenite. The grain is extraordinarily fine for such large bodies, averaging $\frac{1}{2}$ to 1 mm., although locally coarser-grained phases occur. The fineness of the grain and the alteration to chlorite makes the rock very difficult to distinguish (on the freshly-broken surface) from the andesite lava, although the separation is readily made on the weathered surface; and it is probable that this similarity will constitute the most formidable obstacle to correct mapping of the underground workings. As the copper ores occur mainly in the andesites, but not in the gabbro, it is evident that this difficulty is of great importance.

The syenite porphyry is a reddish rock composed of albite phenocrysts in a groundmass of albite with some quartz, and a little titanite, magnetite, and chlorite. Only one narrow dyke of it outcrops on the Horne property, running almost due east about 2,500 feet south of the zero point. In this area it cuts only andesite lava, and is cut by the later gabbro.

The younger gabbro forms two dykes, each 60 to 75 feet wide, the location of which is shown on the accompanying map. This rock is easily distinguishable from the diorite. It weathers a dark limonite-brown, whereas the diorite invariably weathers dark green. It is coarser grained and less altered than the diorite, and the composition is that of an ordinary, somewhat altered, quartz diabase. It cuts the diorite and shows a pronounced chilled edge against it, so that there can be no doubt as to its age relations. Contacts exhibiting this relationship were found in two places, one 1,520 feet east and 1,500 to 1,600 feet south of the zero point, the other 1,725 feet east and 2,950 feet south of the zero point. In the latter locality, as the map shows, the dyke of later gabbro cuts directly across a dyke of the diorite.

Still another basic intrusive may be seen on the Horne claims, the rock termed "basaltic gabbro" in an earlier report.[1] It forms narrow, very fine-grained, black dykes that cut all the rocks of the area. It is well exposed on the face of a huge boulder of later gabbro, about 2,900 feet south and 1,700 feet east of the zero point.

The ore-bodies are masses of sulphides that have replaced the country rocks. In places the sulphides are disseminated throughout the rock in grains and small masses, in other places they have replaced the rock almost completely and form bodies of solid sulphide. The sulphides are mainly pyrite, pyrrhotite, and chalcopyrite. Some zinc sulphide has been found, but it is rare.

The strike of the ore-bodies is not yet fully known, as they are cut by dykes of the diorite. One large lens not thus cut, lying 1,700 feet south and 1,650 feet east of the zero point, strikes north 50 degrees east. Another large mass of solid sulphide crossing the zero north-south line about 75 feet south of the zero point, strikes north 30 degrees east. The trend of the other known masses seems to be in a general northeast direction also, although, as previously mentioned, they are so cut by dykes that the strike is not definitely determined.

Two points of particular interest resulted from the recent study. The first of these is that all the important sulphide bodies so far discovered in the immediate neighbourhood are confined to the area of drag-folding. It is possible that others will be found outside of it, but it seems probable that the drag-folded area was particularly favourable to ore deposition by reason of the fracturing undergone by the rocks within it.

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[1] Geol. Surv., Canada, Sum. Rept. 1922, pt. D, p. 71 (1923).

The second point of interest bears on the relation existing between the wall-rocks and the type of sulphide formed. Wherever sulphide bodies have been found within the rhyolites and rhyolite tuffs, the sulphide deposited is invariably almost pure pyrite. The large sulphide mass 75 feet south of the zero point is pyrite; so are the sulphide masses in the area 700 to 1,100 feet south and 300 to 500 feet east of the zero point; so again are the sulphide masses in the area 1,300 to 1,500 feet south and 600 to 900 feet east of the zero point; again in the area 400 to 500 feet south and 1,700 to 1,800 feet east of zero. Many other instances might also be added. On the other hand, all the masses in which any notable amount of pyrrhotite is found occur within the areas of andesite lavas. Within these lavas the bulk of the sulphide is pyrrhotite and chalcopyrite, and pyrite occurs only in scattered crystals, roughly estimated to form only 5 to 10 per cent of the total sulphide.

Chalcopyrite, as at the Amulet, has been introduced slightly later than the primary sulphides pyrite and pyrrhotite, replacing the pyrrhotite; the pyrite is replaced with difficulty or not at all. It is evident, therefore, that the valuable bodies of copper ore must likewise be confined to the bodies of andesite lava.

A most interesting example of this influence of the wall-rock was seen in a trench 1,300 feet south and 1,030 feet east of the zero point. The trench has been sunk about to the bottom of the zone of weathering on a sulphide body, and cuts across the boundary between the rhyolites and andesites. At this boundary, within a distance of 3 or 4 feet, the character of the sulphide changes sharply from pure pyrite in the rhyolites to pyrrhotite with a small admixture of pyrite in the andesites.

SUMMARY OF OBSERVATIONS ON THE SULPHIDE DEPOSITS

Four important sulphide deposits were studied during 1925: on the Chance, Amulet, Waite-Montgomery, and Horne claims. In addition one or two minor deposits were seen, northwest of lake Dufault. In all cases the sulphides replace the country rock, and are accompanied by little or none of the ordinary vein materials such as quartz, feldspar, or calcite. Magnetite, however, occurs here and there with the sulphides. The introduction of the sulphides seems to have been accompanied by very little alteration of the country rock other than the replacement by sulphide.

The mineral species formed, pyrite, pyrrhotite, and magnetite, with small quantities of hornblende, epidote, and feldspar, on the Chance property, indicate deposition from highly heated solutions, such as must have risen from greater depths through fissures. The fissures or their original inferred position may be seen on the Chance and Horne claims, and also on the Norbeck claims northwest of lake Dufault, but have not yet been located on the Amulet and Waite-Montgomery properties.

The most important result of the work in 1925 is the recognition of the influence of the country rock on the character of the ores. Wherever a sulphide body has been found in light-coloured, acid rhyolite, the principal sulphide is pyrite, with or without zinc blende which appears to be a more or less accidental constituent. If the rhyolite is a massive lava, the sulphide body is apt to be small; but if a tuff, the replacement is more extensive and great bodies of pyrite have developed. On the other hand, the commercially valuable masses of pyrrhotite-chalcopyrite ore have so far been found only within rocks of more basic types, such as the chlorite-rich andesite of the Horne claims, and the biotite-rich dalmatianite of the Amulet property. That this difference is due to the influence of the wall-rock is shown, not only by the fact that no exceptions to the above rule have been found, but also by the change, on the Horne, of pyrite to pyrrhotite deposition within a single mass of sulphide at a rhyolite-andesite contact.

Since, therefore, deposits of commercially valuable ore may be looked for at the intersection of sulphide-bearing fissures with chlorite-rich or biotite-rich lavas, it is obvious that successful prospecting must depend, primarily, on the discovery of a sulphide-bearing fissure, and, secondarily, on a determination of the geology of the area, so that an estimate may be made of the position where the fissure will intersect the more basic flows. Such a position may be beneath deposits of drift, where prospecting would not otherwise be carried. Thus prospecting may be most economically carried on if accompanied by careful geological work.

The origin of the sulphide deposits is not yet known, and only a few facts have been obtained that bear on this question. Since the ores were formed from highly heated solutions, it is natural to turn to some igneous rock of the vicinity as the source of such solutions. Of the igneous rocks on the Horne, later gabbros and the syenite porphyry are younger than the ore-bodies and cut through them, hence cannot be regarded as possible sources. On the other properties intrusive rocks are either absent or are subject to the same objection. The diorite dykes on the Horne property are small and fine grained, and have not been differentiated; so that they cannot have given rise to ore-bodies. The only remaining body of igneous rock is the small batholith of granodiorite around the northern end of lake Dufault, and it is interesting to note how the known sulphide bodies are spaced around its margin. The Horne property lies about 3 miles southwest, the Amulet and Waite are less than a mile from the western boundary. The Chance, and the latest discovery, the Pioneer claims northeast of the Chance, are about 9 miles away, but may have originated from the Lake Flavrian granodiorite batholith only 3 miles to the north.

On the Norbeck claims northwest of lake Dufault, the roof of the granodiorite batholith has been barely exposed by erosion over a considerable area, and in consequence there are numerous patches of lava of all sizes from 1 to 20 feet in diameter, still partly clothing the granodiorite surface. These remnants are of a very acid, slightly greenish, translucent, glassy rhyolite, but in spite of this composition which is most unfavorable for replacement, the few inches of rhyolite next to the granodiorite are filled with splashes of chalcopyrite up to an inch or more in diameter. The proximity of the chalcopyrite to the granodiorite, particularly in view of the inhospitable character of the highly acid rhyolite, strongly directs suspicion to the granodiorite as the source of the mineral. Somewhat farther south, about the middle of claim T 1291, where the cover of lava is thicker and more continuous, there is a fissure which strikes north 60 degrees east, has a vertical dip, and cuts andesite lava. The fissure is filled with chalcopyrite with some pyrite, for widths of 1 to 12 inches. As the granodiorite boundary is close by, and probably less than 50 feet below the surface, the occurrence is suggestive of solutions rising from the igneous mass below.

The facts cited, therefore, point to the granodiorite as being the source of the sulphide bodies, but without proving the supposition. If the conclusion is a true one, then it is obvious that the areas most favourable for the discovery of sulphide deposits are those within 3 or 4 miles of the boundaries of such granodiorite masses, of which there are at least three, namely the Lake Dufault, Lake Flavrian, and Cléricy batholiths.

LA MOTTE AND FOURNIÈRE MAP-AREAS, ABITIBI COUNTY, QUEBEC

By W. F. James and J. B. Mawdsley

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Illustrations

INTRODUCTION

A program of geological mapping in western Quebec was begun by the Geological Survey in 1922 and has since been continued, with the result that there is now geologically mapped a strip of territory extending eastward from the Ontario boundary for a distance of about 70 miles and extending for about 35 miles from north to south. The northern boundary of this area is an east-west line cutting the Ontario boundary at a point about 7 miles south of lake Abitibi and Harricanaw river at a point about 5 miles south of Amos.

Public interest in the district was aroused late in 1922 by the discovery of gold-bearing veins in the vicinity of Rouyn lake. During the summer of 1923 the amount of development work done on mineral showings was disappointingly small and many claims were permitted to revert to the province. Interest increased again late in 1923 and the results of the following year were more encouraging. Development work on the Noranda property gave evidence that copper deposits were worthy of prospecting and in the eastern section some interesting gold discoveries were made. Development work on gold-bearing veins in the western section was also carried out, but interest in deposits of this type was overshadowed by the growing importance of the copper deposits in the vicinity of Osisko and Dufault lakes. Meanwhile the settlement on Osisko lake, known variously as Rouyn City and Rouynville, grew from a few prospectors to a village of several hundred people.

Transportation in the beginning was a serious difficulty, but transport services have been steadily improved. A more nearly adequate boat service was established to connect the Canadian Pacific railway above lake Timiskaming with Rouyn lake, the Timiskaming and Northern Ontario railway was extended from Crown City eastward to the Quebec boundary within easy distance of Osisko lake, and work was commenced on a highway from Taschereau,[1] on the Canadian National railway, to Osisko lake. Surveys were made for a branch railway line from Taschereau to lake Osisko and its construction was begun late in 1925.

[1] Formerly known as O'Brien or Privat.

During the summer of 1925 public interest in the district reached its height. In Rouyn district proper, development work on the Horne, Montgomery-Waite, Amulet, and other properties gave promise of the presence of copper ore-bodies of economic importance. Many individuals, syndicates, and newly formed companies took up the work of prospecting in a much more vigorous fashion than had yet been done. The tendency to work farther afield from Osisko lake became pronounced. Promising occurrences of gold and copper ore were investigated in Cléricy township and in the area east of Duparquet lake. In the eastern section, in the townships of Cadillac, Malartic, and Fournière, considerable work was performed on promising gold occurrences and on several of these work was continued throughout the winter of 1925-26. Farther east, about the headwaters of Harricanaw river, considerable work has been carried on for the last two years, much of it being underground development on gold claims that have been held for many years, and some other promising properties have been staked and worked. Work on molybdenum occurrences has been confined to a small amount of development work on the claims of the Molybdenum Reduction Company, east of La Motte lake. The older workings in the vicinity of Kewagama lake have been abandoned since the end of the war period. Demand for molybdenum may have the effect of stimulating work on these deposits once more.

Just outside the mapped area copper-zinc discoveries have been made in Desmeleizes township and have been followed by a great deal of development and prospecting work. A short distance east of Amos in Landrienne and Barraute townships, gold-bearing veins have been investigated and the results obtained at least warrant further work, which it is proposed to carry out in 1926. Mineralized zones have been uncovered in the district about the upper waters of Bell river and their investigation is under way.

This report is based on field work by the writers during the season of 1925 in La Motte and Fournière map-areas, Abitibi county, Quebec, and is an extension eastward of the geological mapping done during the years following 1922. The areas lie within the belt of volcanic and sedimentary strata that runs eastward from the Ontario boundary. The known mineral occurrences made it desirable to investigate as closely as possible the geological relations in an endeavour to estimate the economic possibilities of the region.

La Motte map-area is bounded on the north by parallel 48° 30′, on the south by parallel 48° 15′, on the east by meridian 78° 00′, and on the west by meridian 78° 30′. Its northern boundary is about 5 miles south of Amos, on the Canadian National railway. Fournière map-area is bounded on the north by La Motte area, on the south by parallel 48° 00′, on the east by meridian 78° 00′, and on the west by meridian 78° 30′. The western boundary of the areas is roughly 20 miles east from Rouyn lake.

Harricanaw river and its connecting waters offer the most convenient route to the greater part of both areas. At Amos, on the Canadian National railway where it crosses Harricanaw river, supplies of all kinds may be purchased and boats secured. Harricanaw river is navigable for small steamers and motor boats for more than 50 miles above Amos. Dredging operations by the Department of Public Works have provided channels along silted parts of the river. These channels have been marked by buoys, which should be followed fairly closely, since rocky reefs occur in many places and are dangerous even for motor-propelled canoes, a type of transport much used in the district. Extensive channels have been dredged where Harricanaw river enters La Motte lake, and where Little Askigwaj river enters the same lake; and a canal about half a mile long has been cut westward from La Motte lake towards Kewagama portage.

In the northern part of La Motte area many of the roads are suitable for motor travel. The principal road south of Amos extends about 20 miles to La Motte lake and is sometimes used for transporting prospectors' supplies. Kewagama portage has been equipped with a track and a motor-driven truck on which supplies and equipment may be carried at reasonable rates. The distance across the portage is a little less than 2 miles. The northern and central parts of Fournière township are most easily reached by trails which run from the intersection of Blouin's Line and Little Askigwaj river. Properties in western Cadillac township are reached by Blake river, a small stream that runs into Kewagama lake. For use in seasons of low water, the O'Brien Mining Company have cut a road from the first rapids on Blake river to their property in central Cadillac township. Claims in eastern Bousquet are reached by good trails leading from the rapids on Kiekkiek (Bousquet) river a few miles from Kewagama lake. The northwestern section of the areas is most conveniently reached by way of Villemontel. A good road runs south from the village to Villemontel river which may be followed to Kinojevis river. Two rapids are encountered on Kinojevis river between its junction with Villemontel river and Kewagama lake. Outboard motors may be conveniently used on practically all the waters mentioned.

During the field season, the writers were very capably assisted by Messrs. T. D. Guernsey, Carl Tolman, R. V. Hopper, A. Ree, R. W. Watson, E. Snyder, E. K. Fockler, J. A. Retty, and C. H. Riordan. The members of the party are particularly indebted to Mr. J. I. Cummings of the Department of Public Works for a great deal of assistance rendered during the season.

PREVIOUS WORK

In 1901, J. F. E. Johnston, of the Geological Survey, made a reconnaissance survey of the geology of the waterways of a large part of Abitibi region. Within Fournière and La Motte map-areas, his work only comprised examinations of the rocks in the vicinity of Kewagama lake and the upper parts of Kinojevis river.

In 1906, W. J. Wilson, also of the Geological Survey, examined the rocks along the main water route from La Motte lake to the north boundary of La Motte map-area. In the same year, J. Obalski, of the Quebec Department of Mines, made a general reconnaissance of the waterways of the district.

In 1909, T. L. Walker investigated the molybdenite occurrences in the vicinity of Kewagama lake. His results appeared in a report on molybdenum issued by the Mines Branch of the Department of Mines.

In 1911, J. A. Bancroft made a geological survey of a large section of the district near Kinojevis river, including the township surrounding Kewagama lake. In the following year, he extended his work eastward to include the townships on the Harricanaw waters. The work done during these two years was of a much more detailed character than any previous work.

In 1910 and 1911, M. E. Wilson, of the Geological Survey, mapped a large section of Abitibi district, but confined his efforts chiefly to such parts as had not been mapped by Bancroft.

Since 1911 work of a detailed character, chiefly in connexion with partly developed properties, has been carried on by officials of the Quebec Department of Mines.

In 1914, T. L. Tanton, of the Geological Survey, made a reconnaissance survey of Harricanaw River basin, chiefly north of the Canadian National railway, but he included in his report a few observations on the rocks of the northern part of La Motte area.

In 1923, H. C. Cooke, of the Geological Survey, during the course of an investigation of a number of the mineral properties in the upper basin of Harricanaw river, made some detailed observations on the nature of the volcanic rocks to the southwest of La Motte lake and an examination of some claims in Malartic township.

In 1924, G. W. Bain, on behalf of the Geological Survey, further investigated the country surrounding and lying east of Harricanaw river.

AGRICULTURE

Agriculture in the northern part of the map-areas has already become of considerable importance. Settlement began in the vicinity of Amos about the time of the construction of the Canadian National railways and has already advanced a fair distance up Harricanaw river. Many of the farms in the more accessible localities are in a fair state of cultivation, and the construction of good roads is being followed by the improvement and settlement of considerable land at a distance from the main waterways. A great part of the soil in the northern part of the areas is suitable for cultivation and it is reasonably expected that in the near future a large farming population will occupy the country south of Amos. Settlement along Harricanaw River system now extends to the southern boundary of La Motte township and is gradually being extended east and west of the river and its lakes. At present only one settler has cultivated a farm in Malartic township. Settlement in Villemontel township has not yet reached the northern boundary of La Motte map-area, but it is only a matter of a short time until the large clay area that occupies the southern part of this township will be put under cultivation. Some areas of these townships where rocky hills are few are nevertheless too sandy for cultivation.

Root crops and hay seem best adapted to the soil and climate of the district, but the large hay crop cannot be disposed of because of the long freight haul to Montreal and Quebec, the nearest large markets. The solution of the problems of the new settlers seems to lie in the raising of good dairy herds and the establishment of local dairies at convenient points for the manufacture of butter. The cost of bearing this product to the cities of Quebec should not be so great as to prohibit its sale at a profit.

TIMBER

The timber of the map-areas is still of some importance, though in the northern and settled section the clearing of land for farms and some disastrous fires have destroyed a great deal of it. This is also the case in large areas of the southern and less frequented townships. Some red pine is to be found, but the bulk of the forests is composed of spruce, generally suitable for pulpwood, though in places sufficiently large for use as saw-logs. The eastern section of Manneville township has suffered from fire. Fire and clearing of lands have removed a great part of the timber of Figuery and La Motte townships. A serious fire in the vicinity of Kewagama lake has destroyed much of the timber of Preissac township and of the northern parts of Bousquet, Cadillac, and Malartic townships. The southern sections of these have in general suffered less loss from fire. The bulk of the good timber is confined to the southern townships, Montanier, Surimau, and Fournière, although even in these fire has destroyed many square miles of valuable timber. In these townships are a number of good stands of red pine, but many of which are at a considerable distance from a stream of sufficient size to permit of the logs being driven to any of the principal rivers. Lumbering operations are now being carried on in Malartic and Cadillac townships and in the vicinity of Kewagama lake.

DRAINAGE

The height of land between waters flowing to James bay and those flowing into Ottawa river follows a line which roughly bisects the map-areas from north to south. Harricanaw river is the largest of the north-flowing streams and within the map-areas has three large expansions which constitute lakes La Motte (Malartic), Okikeska (La Motte), and Figuery. The bulk of its water flows from a chain of large lakes to the southeast. Because of its proximity to the height of land the streams flowing into Harricanaw river from the west are few and small. A very narrow strip east of the river and within the map-areas drains into it, but the course of the bulk of the drainage east of the river is southward, joining the river some distance east of the areas. No rapids occur on Harricanaw river for about 60 miles above Amos and very few even on the smaller streams. Except for a few deep channels which may mark the presence of older river channels the lakes are very shallow.

West of the major height of land, the greater part of the map-areas is drained by Kinojevis river and in the southern part a small area drains directly into Ottawa river. A number of small streams flow into Kewagama lake and thence into Kinojevis river. None of these water-courses is worthy of the name river. The chief drainage channel into Ottawa river is Darlens river, which follows a meandering course through Montanier and Surimau townships. In time of high water, this stream may be ascended from Ottawa river as far as the central range line of Montanier township. Surimau and Montanier are notable for the scarcity of even small lakes within their boundaries.

TOPOGRAPHY

The major part of the map-areas lies within the great, undulating, plain-like region which slopes gently northward to James bay, only the southern part being included in the rough, rocky country, through part of which flow the headwaters of Ottawa river. The flatter section is mostly floored with the clayey or sandy deposits of the post-Glacial lake that once occupied many thousands of square miles in northern Ontario and Quebec. The level surface of this plain is broken by many knobs and ridges of rocks which rise through the drift cover and attain elevations more often to be measured in tens than in hundreds of feet above the general elevation of the region. The general elevation of the country above sea-level is somewhat less than 1,000 feet and the figure 966 feet for La Motte lake is also approximately correct for most of the larger waters. Though no elevations were determined during the field work, it seems probable that few of the major ridges exceed 1,200 feet and that most of the minor knobs are in the vicinity of 1,000 feet above sea-level.

The flat areas are very poorly drained, with the result that swamp areas are large. Several single swamp areas were noted with areas of more than 3 square miles. Some of these swamps are properly called muskegs, that is they have originated from the filling of old shallow lake bottoms. Others having superficially the same appearance have had a somewhat different origin. They are better described by the term "moss-swamps." In these swamps it is noted that there is an accumulation of organic soil and moss lying on top of the flat clay or sand beds. The swampy character seems to be due to the retention of moisture by the organic material, the poor drainage of the area, and in many cases the impervious character of the soil. It is probable that the organic material is simply the product of moss growth since a previous fire, or even in some cases since the recession of the glacial lake. It is noticed that when these areas have been subjected to intense fires they rapidly dry up, so that on the same plain a swamp in a forested section grades rapidly into a dry, sandy or clayey plain where fire has destroyed the vegetation.

Streams commonly rise in such wet plains and follow a meandering course through them. The banks of these streams are quite steep due to the rapid cutting of the swollen streams, during seasons of high water, into the soft drift beds.

The sandy areas probably formed as outwash plains at considerable distances from the ice edge during the recession of the ice-sheet. Most of the flat areas are, however, floored by clay which was the normal material deposited in the large post-Glacial lake which once covered the region. From rather extensive observations throughout the Harricanaw basin, Bancroft noted that most of the clay areas lie below 1,000 and never more than 1,040 feet above sea-level, which suggests that the surface of the glacial lake was not above this level for any appreciable period.

The principal lakes occupy shallow depressions in such flat areas. Few of them are more than 7 or 8 feet deep over large areas. Extreme depths such as one in excess of 100 feet in lake La Motte and one of 40 feet in lake Kewagama, are probably to be explained by the presence of old river courses pre-Glacial in origin. Shallow areas 4 feet and less in depth form by far the greater parts of all the lakes. It is notable that the number of lakes in the clay areas is less than in the rocky areas so general throughout the Canadian Shield.

Wilson has suggested the name "Rocky Uplands" for those parts of the western Quebec district that are not generally flat and underlain by clay. The rocky upland type of topography consists of small, isolated knobs and ridges which protrude through the clay and also of larger areas in the south of Fournière map-area where little or no clay occurs and which may be considered as continuous with the rocky upland topography of the upper Ottawa basin.

GENERAL GEOLOGY

La Motte and Fournière map-areas are generally similar to the areas already mapped to the west and are underlain for the greater part by rock formations which extend eastward from these areas. Bedrock consists of early Precambrian rocks and is overlain by extensive deposits of Glacial and post-Glacial drift. The oldest rocks of the Precambrian are volcanic flows and sediments of volcanic origin. In addition there are great thicknesses of sediments, mostly of normal clastic type but very much altered by dynamic and thermal metamorphism. The bulk of these sediments is younger than the bulk of the volcanics, but some volcanics occur in what is considered to be a stratigraphically higher position than that held by some of these sediments. No satisfactory evidence of angular unconformity between the sedimentary and volcanic formations has been found and the formations as represented on the geological map have, therefore, been distinguished chiefly according to a lithological basis. Included within the volcanic series are basic igneous rocks, some definitely intrusive and all probably so. Cutting these older rocks are a number of granitic intrusives. Younger than these are a number of gabbro dykes, which seem to represent the last directly recorded stage of the Precambrian history of the areas.

Table of Formations

Recent and Pleistocene
Pre-Cobalt (?) intrusives
    Olivine- and quartz-gabbro dykes
Pre-Cobalt intrusives
    Granite, granite porphyry, granodiorite
    Porphyritic syenite
    Augite syenite
    Amphibolite
Timiskaming
    Greywacke, some arkose, and schists; basic flows and tuffs; conglomerate
Timiskaming or Keewatin
    Sedimentary schist
Keewatin
    Basalt, andesite, rhyolite, tuff, and basic intrusives

KEEWATIN

The principal area of volcanics is continuous with an area of similar rocks that extends west to the Ontario boundary. Within the general area of the volcanics are large bodies of granitic intrusives and some bands of sedimentary gneiss, and as a result the area actually underlain by volcanics is much less than in the map-areas to the west. Manneville, Villemontel, and Figuery townships, except along their southern border, are mostly underlain by volcanics, though there are present some minor bodies of intrusive and some sedimentary schists, and in addition large areas within Villemontel and Figuery townships are completely covered by drift. Smaller areas of volcanics and basic intrusives occur in Preissac township adjacent to sedimentary schist, and intruded by large bodies of granite. Areas of the volcanics and basic intrusives occur in La Motte township, chiefly in the central and southeastern parts. In Cadillac township a narrow strip of such rocks lies south of Kewagama lake, and, interrupted by drift areas, extends east through Cadillac township into Malartic township where these rocks underlie an area surrounding lake La Motte.

The volcanics of the two map-areas are dominantly basic in composition, such acid lavas as rhyolites and trachytes being rather rare. The volcanics are almost entirely andesites or basalts, which in the central part of La Motte area have undergone considerable metamorphism due to the granitic intrusives that cut them. Elsewhere towards the southern contact of the volcanics in Malartic and Cadillac townships, where intrusives are small in extent, metamorphism is considerably less. It is remarkable that, except in the highly metamorphosed areas, the volcanics preserve many of their minor structures and textures, even though they have suffered considerable alteration in mineral composition.

The acid lavas, which include such rocks as rhyolites and trachytes, form only a small fraction of the volcanics and appear as thin, individual flows lying between more basic flows. They contain spherulitic facies and are locally rudely pillowed, with occasionally some evidence of flow structure. They are usually white on the weathered surface, though the colour of the fresh rock may vary from milk white to black. In the rhyolites, phenocrysts of quartz and feldspar attain a small size, usually not over 2 mm. Trachytes contain phenocrysts of feldspar only and these, being more acid, are less altered than the more basic feldspars of the other volcanics. The groundmass of the acid volcanics is very fine in grain, may be in part devitrified glass, and is made up of small grains of feldspar and quartz with grains of secondary minerals such as epidote and the carbonates. Trachytes are distinguished from rhyolites by the much smaller amount of quartz present.

The basic lavas, which form the greater part of the volcanic rocks of the areas, are typical of what are usually called greenstones in Precambrian formations. A common and striking feature is the pillow structure, which seems to reach its greatest development in the andesites. Pillows range from a few inches to 10 feet in length and have a width of about half their length. Pillows also occur in the basalts, although they do not as a rule attain such large dimensions.

Spherulitic structure occurs in the basic as well as in the acid lavas. The spherulitic lavas are rather striking in appearance and consist of light-coloured, almond-shaped spherules, in many cases up to an inch in length, embedded in a greenish groundmass which seems to be of more basic composition. Amygdaloidal lavas are also common among the basic types. The amygdules tend to be rounded or lenticular and represent original cavities in the lava now filled by such minerals as quartz, epidote, zoisite, and carbonates. The light colour of the amygdules, in contrast with the usually dark rock, renders them conspicuous and in places they are more resistant to weathering and stand out in relief from the rock surface. The mineral fillings are usually arranged in concentric layers.

Microscopic examination of the lavas shows that in most cases they have been much altered mineralogically. The feldspars, though occasionally fairly fresh, are usually almost completely replaced by secondary products such as white mica and carbonates. Augite is seldom seen, being probably replaced by the green hornblende that forms the bulk of the ferromagnesian mineral present. Minerals such as epidote, zoisite, and the carbonates form a large part of some of the sections examined. Some quartz, also probably secondary in origin, occurs. In some sections a porphyritic tendency is visible, fairly large phenocrysts of plagioclase feldspar having developed.

Fragmental beds associated with the lavas vary greatly in character. They range from such as are the brecciated tops of flows or are beds of coarse fragments of lava to others that are composed of fine, thinly bedded material which was probably fine volcanic debris deposited in water. There are also associated facies which are in part due to the operation of non-volcanic sedimentation that occurred in the intervals between the outpouring of the flows. Such sediments differ from the purely volcanic facies in having a larger proportion of rounded fragments.

Peridotites and Basic Intrusives

Associated with the Keewatin lavas are masses of dark igneous rock whose structural relations are as yet unknown. The principal occurrences lie within a zone a mile or more wide, which begins in Preissac township at the north end of lake Chassignolle, skirts the northern shore of lake Kewagama, and trends southeasterly through La Motte township, widening out on the eastern shore of La Motte lake at the entrance of Harricanaw river. The number of outcrops within this zone is relatively small and some are of basic rocks that seemingly are altered lava flows, but outcrops of the basic igneous rock predominate. Other outcrops of these rocks appear in the low hills near the middle of La Motte township. These various occurrences have not been differentiated on the accompanying map from the Keewatin flows.

These basic rocks show many different facies and various degrees of alteration, but all exhibit a certain general similarity. They are generally green, varying from light to very dark, and, except the less altered phases, are easily scratched, due to the presence of considerable talc, chlorite, and carbonates. Some are much sheared and others have a mamillary surface on which much carbonate is visible. At one outcrop on the east shore of La Motte lake, near the point where Harricanaw river enters, fibrous serpentine was observed along what appears to be a slippage plane. The rocks vary from coarse-grained phases in which the individual constituent minerals may be clearly seen, to very fine-grained phases. Large flakes of mica appear in some of the coarser phases.

Thin sections from various localities show considerable difference in composition. One from the vicinity of the St. Maurice mine in Preissac township seems to be composed chiefly of talc and fine fibrous serpentine with a little black iron ore. In others the principal mineral seems to be a pale, pleochroic hornblende with talc and serpentine. Black iron ore forms linear aggregates about the borders of some of the crystals. Less altered phases, made up principally of the olivine, colourless augite, and hornblende, also occur. Black iron ore is a prominent accessory in almost every case and locally brown mica is important. Carbonates are also prominent accessories and may in cases form a large proportion of the rock.

Nothing definite is known of the relations of the peridotites and basic intrusives with the sedimentary schists and the volcanics with which they are in contact. They are cut by granite on Kewagama peninsula and hence are older than the granite. Small masses of peridotite occur within the lavas, but whether these bodies are offshoots of the main mass and cut the lavas cannot be definitely stated.

TIMISKAMING OR KEEWATIN

Closely associated with the Keewatin volcanics of La Motte map-area are several bands of schist considered to be of sedimentary origin, but whose relation to the volcanics is unknown. The presumption is that these schists either occupy a position within the Keewatin and were sediments originally laid down with the lava flows, or they were deposited after volcanic activity had ceased and hence would be considered as being of Timiskaming age. Two major bands separated by a considerable body of granite occur in the northern section of La Motte area. It is not known whether or not they at one time were continuous. The westernmost band lies in the southern part of Villemontel and the northern parts of La Pause and Preissac townships. The other band extends from a few miles west of Harricanaw river in Figuery township, where it is represented by a very few outcrops, to the southeast corner of Figuery township.

In Preissac township, separated from the first-mentioned band by a band of basic igneous rock, is another band of much metamorphosed sedimentary schist. This band is much interrupted by intrusions of granite and by drift-covered areas, but seems to extend southeasterly into La Motte township where outcrops are scarce. A few outcrops of a somewhat similar rock occur on the southern shores of Chassignolle lake and seem to be the extension of the Cléricy sedimentary band of the map-area just to the west.[1] In the eastern part of La Motte township, about 3 miles north of

[1] Geol. Surv., Canada, Sum. Rept. 1924, pt. C, p. 107 (1926).

the southern township boundary, is another outcrop of sedimentary schist, which is reported to extend south and east beyond the limits of the map-area.

These rocks generally occur in proximity to intrusive granitic rocks and have been greatly metamorphosed, particularly in areas close to the granite where they have been converted to mica schists. Hornblende schists also occur. It is thought that the schists were originally fine-grained sediments similar to the greywackes of the Timiskaming which they resemble. No conglomerates are known to occur, though they may have existed and have been completely converted to fine-grained schists by the contact action of the granites.

The schists vary in appearance. Those whose hornblende content is high are dark-coloured rocks of medium grain and have a fairly high quartz content. Many of the micaceous schists are banded in light and dark bands, the dark bands being rich in mica, whereas the light bands are richer in quartz, with locally some plagioclase. Thin sections show that in the more metamorphosed phases, the mica or hornblende crystals are oriented in the direction of the shearing of the rock.

TIMISKAMING

According to the usual conception, the Timiskaming is a series of rocks dominantly sedimentary in character, lying stratigraphically above the Keewatin, and separated from it by an angular unconformity. To the west, in Opasatika map-area, H. C. Cooke found that the structure of the Keewatin is discordant with that of the sediments to the south and partly on this basis he classed the sedimentary series as Timiskaming.[1] The sediments of Opasatika map-area extend continuously to the east and underlie much of the southern part of the present map-areas where they have the same general character as in Opasatika map-area and manifestly are of the same age. The unconformity deduced by Cooke to exist in Opasatika area between the Timiskaming and Keewatin does not occur within the present map-areas. In Malartic township, where outcrops are fairly good, it was definitely determined that the volcanics underlie the sediments as in the west, but the strike of the volcanic formation very closely parallels that of the sediments to the south. Bands of volcanics similar in character to those of the Keewatin occur within the area of Timiskaming sediments and, therefore, are younger than the Keewatin, unless they owe their present position to complex folding or faulting, which seems improbable. Instead, the volcanics seem to be interbanded with the sediments. The logical interpretation seems to be that the dominantly volcanic series to the north represents the Keewatin with which it is continuous, and that the overlying dominantly sedimentary series to the south is the Timiskaming, but that the change from essentially volcanic conditions (Keewatin) to mainly sedimentary conditions (Timiskaming) took place gradually and without the folding of the older series as in localities to the west in Ontario and Quebec.

[1] Geol. Surv., Canada, Sum. Rept. 1922, pt. D, pp. 40-41 (1923).

Adopting the above-stated interpretation, the division between the Timiskaming and the Keewatin has been drawn at the southern edge of the main body of the volcanics where they adjoin younger sediments which have interbanded with them a number of volcanic bands. The line of division can not be sharply drawn. The volcanics contain beds of normal tuff, of waterlain tuff, and of material which differs not at all in appearance from some of the finer sediments of the Timiskaming, and the proportion of sediments increases southward toward the main body of Timiskaming sediments.

The Timiskaming as mapped consists of finer sediments, such as greywacke and arkose, a few narrow bands of conglomerate, and some narrow bands of volcanics. It is cut by granitic rocks of several compositions, by lamprophyre, and by the later gabbro. In the vicinity of the granitic intrusions metamorphism is considerable and in the southernmost townships, where these granitic rocks underlie very large areas, all that remains of the sediments are a few masses of mica schist included in a large body of granite.

The fine sediments have a grain usually less than 1 mm. They show their original bedding planes even where largely metamorphosed to mica schist. The bands vary from a fairly light grey to black, according to the amount of mica and the lighter silicates present. The bands in many places are paper thin, but locally attain thicknesses as great as several feet. In most places the beds are an inch or less in thickness. Quartz and biotite are the principal constituents of the greywackes, a small amount of feldspar is also usually present. The abundant mica is probably due to the recrystallization of basic minerals originally present in the rock. Microscopic examination indicates that recrystallization is generally quite complete.

The rocks classified as arkose are somewhat similar to the greywackes except that they contain a higher proportion of feldspar, much of which is twinned and remarkably fresh looking. The arkoses are much lighter in colour and tend to be somewhat coarser in grain than the greywackes.

The conglomerate bands lie near the northern margin of the sediments. In places as many as three bands occur within a north and south distance of 1½ miles. The exposed width of individual bands is from 100 to 500 feet. No one band is traceable for more than 2 miles along its strike, but the heavy cover of drift is no doubt responsible for this apparent lack of continuity. The conglomerates are made up of well-rounded boulders and pebbles in a matrix that is in many cases fairly coarse. The boulders and pebbles, which form from 30 to 80 per cent of the rock, range in size from 10 inches down to less than an inch, but are usually from 2 to 4 inches in diameter. Some of the boulders have been elongated by pressure, whereas others of more brittle material have been fractured at right angles to the direction of pressure. The pebbles vary in composition. Rhyolites and rhyolite porphyries predominate, but large numbers of pebbles of basic volcanics, jaspilite, granites, and syenites are present. Some of the pebbles are arkose. The groundmass is arkose or greywacke with a grain of from 1 to 2 mm., but dark, slaty material also forms the matrix in some cases. Where pressure has been intense the groundmass is in many cases sheared and micaceous or chloritic.

The volcanics form narrow bands within the sediments. They are similar in composition and appearance to the andesites of the Keewatin. Pillowed phases and also porphyritic facies, occur.

GRANITE AND ASSOCIATED INTRUSIVES

Granite and associated intrusives are widely distributed throughout the map-areas. They form two main areas and a large number of small, irregular bosses and dykes scattered throughout both map-areas. The northern granite area occupies the greater part of Preissac and La Motte townships, extending northward into Manneville, Villemontel, and Figuery townships and southward into Cadillac and Malartic townships. This granite area continues east of the map-areas. Within it and mostly to the east of Harricanaw river, are several small areas of more basic rocks, which have been differentiated on the accompanying geological map. It is roughly bisected by an area of biotite schists, chlorite schists, and basic igneous rocks, which extend along the north shore of Kewagama lake and form a narrow band extending eastward to Harricanaw river. The southern granite mass occupies the larger part of Montanier and Surimau townships, extending a short distance northward into Cadillac township and eastward into the southern part of Fournière township. The contact of the granite and the sedimentary gneisses is more crenulated and irregular than the boundaries of the northern granite area. Within the southern body occur many large and small masses of the intruded schists. Many small knobs and masses of the granitic rock occur within the schists, but decrease in numbers northward. As in the northern section areas of more basic intrusive are also present.

The bulk of the northern granite mass is of a pegmatitic type. The usual variety is almost white or light grey and varies from medium to coarse, and is occasionally porphyritic to some degree. Coarse feldspars in places give it a pinkish colour. These lighter-coloured varieties are usually poor in ferromagnesian minerals. Biotite is the most common ferromagnesian mineral, but locally gives place in whole or in part to a white mica. Quartz and feldspar make up the greater part of the rock. The feldspars are twinned plagioclase, either albite or acid oligoclase, microcline, and some orthoclase. Well-crystallized garnets are common and small grains of epidote and sphene are visible in many places. In some thin sections of this type of granite, a small amount of green hornblende and considerable epidote are present. The plagioclase shows some alteration products distributed along twinning lines, but on the whole the rock is little altered. Sphene and garnet are prominent accessories in some thin sections.

The porphyritic phases may form irregular masses within the granite, though in one case at least, on the west shore of lake Chassignolle, the porphyritic phase forms a dyke cutting basic igneous rocks. This type is similar in composition to the more ordinary phase, but carries phenocrysts of feldspar, quartz, and the ferromagnesian minerals in a fine-grained groundmass of quartz and feldspar with some small grains of ferromagnesians. The ferromagnesian mineral is a colourless hornblende. Phenocrysts do not as a rule exceed 3 mm. in diameter.

Phases of the granite in which hornblende completely takes the place of the biotite and muscovite, occur usually in the marginal parts of the granite mass and probably represent a less differentiated phase of the original granite body. Except for the predominance of the hornblende, this phase is similar to the common variety in composition and habit.

The granite of the southern area is similar to that just described, but intrudes a different type of rock and is more involved with the intruded rock. Within the granite are innumerable inclusions of the intruded rock, ranging in size from mere shreds to blocks a mile or more in diameter.

The bulk of the granite is of the pegmatitic type and in certain localities large areas are completely underlain by coarse pegmatite. Such a locality is that just west of lake Lemoine. Hornblende granite seems mainly restricted to the marginal phases, though locally it appears to form segregations within the pegmatitic variety.

Pegmatites which are important because of their occasional molybdenite content, form considerable bodies within both of the granite areas mentioned above. Prominent dykes and masses occur within the granite and cutting the schists in Preissac and La Motte townships. They also form a considerable proportion of the southern granite area, and probably show their greatest concentration towards the southern boundary of Fournière map-area. This type of rock is characterized by very large crystals of quartz and feldspar, measuring up to 6 inches in diameter. Graphic intergrowths of quartz and feldspar are common. White mica occurs in large plates. Other associated minerals are molybdenite and bismuthinite, which are locally present in some concentration, and rarely beryl.

Aplite dykes were sparingly found adjacent to and in areas of granitic intrusives. They are mostly narrow and rarely exceed a width of 10 feet. Their usual colour is pink. They are fine-grained and holocrystalline; no porphyritic tendency was seen. The feldspar present is orthoclase, in many cases rich in perthitic rods of plagioclase, quartz is commonly abundant and forms grains equal in size to those of feldspar. Ferromagnesian minerals are virtually absent, a little hornblende and magnetite are found. One outcrop on the west shore of Okikeska lake showed the following intrusive sequence: a pegmatite dyke cut by an aplite dyke and it in turn by quartz veins.

Associated with the granites and probably originating as differentiation products from them, are small bodies of more basic rocks. These intrusives have been classified as porphyritic syenite, augite syenite, granodiorite, and amphibolite.

The principal occurrences of porphyritic syenite lie along the northern margin of the southern granite area, in Surimau and Fournière townships, and a smaller number of bodies occur in the northern part of Preissac.

township. The same rock variety occurs in the Cléricy and Kinojevis map-areas just to the west. Though it has a porphyritic tendency it does not consist of well-developed phenocrysts in a groundmass of finer crystals. The rock is essentially a syenite in which in many places some of the feldspars are idiomorphic and of considerable size. Many of the pink feldspar crystals attain a diameter of half an inch, though most of them are somewhat smaller. The ferromagnesian mineral is hornblende which forms small crystals that are in some places interstitial. The proportion of feldspar to hornblende is about as 4 is to 1. In thin sections the rock is seen to consist essentially of large crystals of feldspar surrounded by smaller crystals of feldspar and hornblende. Microcline and orthoclase together are about equal in amount to albite-oligoclase. Perthitic intergrowths of orthoclase and oligoclase are common. The hornblende is in many cases bluish green and in small crystals interstitial to the feldspars. Some small intergrowths of quartz and orthoclase are interstitial to the other crystals. Biotite is present in small amount, but in some cases is the only ferromagnesian constituent. Apatite and zircon are accessory minerals. Classified for mapping purposes with the porphyritic syenite, are some normal and some quartz syenites in which there is no appreciable quantity of hornblende and in which the porphyritic tendency is not at all developed.

The augite syenite is generally equigranular, though in places slightly porphyritic. Ordinarily the grains have a diameter of about 4 mm. Ferromagnesian minerals make up about 40 per cent of the rock and consist of stumpy, in many cases idiomorphic, crystals, of augite or hornblende, which are black with a greenish tinge. The feldspar is generally pink. A small amount of quartz occurs in some specimens. Under the microscope, the augite is almost colourless and shows many stages of alteration to green hornblende, which in some cases occurs almost to the exclusion of augite. Most of the hornblende seems to be secondary after augite. The ferromagnesian minerals lie in a groundmass of smaller, almost equigranular, individuals of microcline, twinned acid plagioclase, and orthoclase which is in many cases altered. Grains of quartz are rather rare. In one locality myrmekitic intergrowths of quartz and albite were observed. The accessory minerals noted are sphene, apatite, and a little biotite.

A mass of granite porphyry occurs at the southern end of La Motte lake with an apparent length of about 5 miles and an exposed width of a little over a mile. It outcrops chiefly on the points along the southern shore of the lake and on a few of the islands near this shore. Greenstones surround the intrusive and are cut by it. In places an almost equigranular texture is observable in this rock, but usually a porphyritic tendency is present. In the eastern part both quartz and feldspar phenocrysts occur, with the feldspars predominating, whereas in the western part quartz phenocrysts become fewer and finally only feldspar laths remain. The groundmass is usually green and on some well-glaciated surfaces the feldspar crystals and the bluish quartz eyes show prominently against this dark background. On freshly broken surfaces the phenocrysts have much the same appearance, but the groundmass is nearly black or a dark greyish green. The percentage of phenocrysts to groundmass varies in different parts of the intrusive, but usually the phenocrysts form 50 per cent or more of the volume of the rock. The quartz phenocrysts are from 2 to 4 mm. in length and usually opalescent. Some show their typical crystal outline, but the majority are rounded. The feldspar phenocrysts are larger than the quartz crystals, varying between 2 and 8 mm., and are usually idiomorphic. They are acid plagioclase in many cases much altered. Phenocrysts of hornblende much altered to chlorite are common and biotite was seen in some specimens. The green groundmass is fine-grained, the grains not exceeding ½ mm., and consists largely of quartz and feldspar. The bulk of the feldspar is orthoclase, but plagioclase, probably albite, is also present. Chlorite, epidote, carbonate, and limonite also form part of the groundmass and appear to be alteration products of the ferromagnesian minerals that once existed in the groundmass.

The rock is jointed on a small scale. Locally it is strongly sheared, as on the northern shore of the large island in the western part of the southern bay of La Motte lake where except for a few, small, rounded phenocrysts of opalescent quartz the rock is fine-grained and largely altered to carbonate. Throughout the rock are small stringers of pyrite. Some trenching has been done on the shear zone, but no information is available as to the presence of gold.

The porphyry is exposed on a prominent point on the west shore of La Motte lake, in range VI. This occurrence is at the western border of the intrusive, and is a typical feldspar porphyry. In this outcrop the long axes of the feldspars tend to be oriented south of east, probably due to movements in the magma. The rock here has a slightly mottled and banded appearance due to variations in the size and content of phenocrysts.

On the south shore of Figuery lake in Figuery township is a body of granodiorite whose exposed length along the shore is somewhat less than a mile and whose width is less than one-quarter mile. East of this mass, within a distance of 3 miles, are two outcrops of a similar rock. These intrusives definitely cut the lavas with which they are associated.

The rock varies in colour from pink to reddish and has the general appearance of a quartz-poor granite. It shows considerable shearing which has an east-west strike parallel to its contact with the volcanics and to the bedding in the volcanics. The grain of the rock is about 3 mm. The feldspar is oligoclase with some orthoclase. The ferromagnesian mineral is hornblende locally much altered to chlorite. Quartz is present in small amount.

Amphibolites, considered to be a basic phase of the granitic intrusives, in which the feldspars are practically absent, are not widespread. The most important outcrops occur in range VII, La Motte township, near the east township boundary in the southeast quadrant of Cadillac township north of Héva river. It is a dark green rock, coarse in grain up to 1 inch, and consists almost completely of large, green crystals of hornblende with locally a small amount of interstitial feldspar. Small inclusions of this type of rock also occur within the granites and seem to be segregations of basic material within the more acid rock.

PRE-COBALT (?) GABBRO DYKES

Dykes of gabbro occur in both La Motte and Fournière map-areas. Both olivine and quartz gabbro occur. A quartz gabbro dyke which skirts the western side of the peninsula in Kewagama lake is apparently part of a dyke which has been traced from the centre of Montanier township, north-northeast to the northern part of Preissac township, over a length of more than 25 miles. An olivine gabbro dyke which skirts the eastern side of the same peninsula, seems to be part of a dyke recognized at intervals from the vicinity of Kinojevis river in Joanne township northwest to southern Figuery township, a total distance of about 30 miles. Its strike is about northeast and it should intersect the aforementioned quartz gabbro dyke in the southwestern corner of Kewagama lake, but the intersection of the two dykes was not observed. If the relation between the olivine and quartz gabbro dykes is the same as in Ontario, the olivine gabbro is probably the younger. At least three other, very long dykes run northeast through Cadillac, Malartic, and La Motte townships. These dykes have slightly convergent strikes and probably intersect in the northeast part of Cadillac township.

In only a few cases could the widths of the dykes be measured. It is apparent, however, that the larger dykes have a maximum width of about 500 feet, but locally are narrower. Smaller dykes in many places are less than 10 feet wide and small stringers from the larger dykes are even narrower.

In hand specimens it is difficult to discriminate between the two varieties of gabbro. Both are composed chiefly of augite and plagioclase and neither the quartz nor the olivine is conspicuous. Both rocks vary in size of grain according as specimens are taken from the contact areas or from the central parts of the dykes. At the contacts, the gabbros are dense, black rocks which in some instances display tiny phenocrysts of feldspar. This fine-grained rock within a short distance of the contact passes into a coarsely crystalline phase in which the crystals of augite and plagioclase may be readily distinguished. In the weathered phases, the olivine gabbro has a slightly more rusty appearance than the quartz gabbro, probably as a result of the weathering of the olivine.

The quartz gabbro is a rock of variable grain, but in the coarser phases with crystals about one-quarter inch in diameter. In colour it is mottled grey and black. The black colour is given by the augite crystals. The grey feldspar crystals have in many cases a greenish cast, due to alteration. A black, flecked appearance is given by occasional flakes of biotite. The ophitic texture is more obvious in specimens of medium grain and not at all apparent in the extremely coarse phases. Microscopic examination shows that in some sections the augite is considerably altered to green hornblende, though probably some green hornblende is primary. With some of this hornblende, brown biotite is in parallel intergrowth. The plagioclase is almost always twinned and fairly basic in composition, approximating a basic andesine or a labradorite. It shows ophitic relationships to the augite and is in lath-shaped crystals. Quartz is present in micrographic intergrowth with the feldspar and in vermicular as well as in irregular-shaped grains. It is apparent that this quartz is much later in crystallization than the other minerals. Magnetite, probably titaniferous, apatite, epidote, and zoisite are accessory minerals. The finer phases of this rock appear very much like fine volcanics. They are composed of a mat of fine feldspar crystals which jut into small augite crystals and are of quite even grain, except for a few larger crystals of feldspar.

The olivine gabbro attains a coarser grain than the quartz variety and on the weathered surface tends to have a more rusty appearance, but as mentioned above is very similar in appearance. The feldspar is basic in composition, in one section being determined as basic andesine (Ab_{55} An_{45}). It probably is more basic locally. Olivine forms large grains, much altered and carrying in its cleavage cracks considerable quantities of grains of black iron ore. The olivine and the plagioclase crystallized prior to the augite, whose outlines are adapted to these older crystals. Some brown biotite which encloses apatite crystals and grains of black iron ore is also present in small amount. The augite is almost colourless, but with the faint purplish tinge said to indicate titanium. It is somewhat altered to green hornblende. Most of the gabbro specimens examined are remarkably fresh in appearance.

The gabbro dykes cut the sediments, the volcanics, and the granites. M. E. Wilson classified these dykes provisionally as Keweenawan. H. C. Cooke in Opasatika map-area considered that the dykes were older than the Cobalt sediments. There is, however, a remarkable similarity between these dykes and those of Keweenawan age studied in Ontario. The most interesting feature is the remarkable length over which the dykes may be traced and their lineal character. In no case was any displacement observed on either side of the fissures marked by the dykes. It is notable that the trend of the larger dykes is generally about the same and is between north and northeast. Bancroft[1] noted that calcite and quartz veins carrying galena, zinc blende, and pyrite were genetically associated with the diabase dykes and that the rock adjoining the dykes was in places impregnated with sulphides.

ECONOMIC GEOLOGY

Interest in La Motte and Fournière map-areas until recent years was centred in the molybdenite prospects found there. Coincident with the discoveries in Rouyn area, free gold occurrences have been found and prospecting for gold within the map-area has been given an impetus. Late in the season of 1922 gold was shown to be present on claims staked by Mr. John Mack in the southwest corner of Malartic township, and later prospecting showed the presence of gold at various points in a zone extending from the locality mentioned southeast towards lake Piché. The largest amount of work in the southern section has been performed on the claims of the Malartic Mining Company in Fournière township. In the western

[1] Dept. Col., Min., and Fisheries, Quebec, "Rept. on Mining Operations . . . during the Year 1911," p. 179 (1912).

section, in Bousquet township, considerable staking has been done and on some claims, notably on those of the Montreal Exploration Company, a considerable amount of surface work has been done. In 1924 prospecting in the central part of western Cadillac township led to the discovery of spectacular free gold occurrences on which considerable work has since been done. Late in the season of 1925 a large number of claims were staked in the southwest part of Malartic township, and it is planned to carry out development work on them during the season of 1926.

MALARTIC MINING COMPANY'S CLAIMS

The claims of the Malartic Mining Company lie about half a mile west of the centre line of Fournière township and near the northern boundary of the township. A large number of claims have been staked, but the principal work has been confined to the claim staked in the name of W. E. Matthews, under Mining Licence No. 2129. The claims were staked in 1923 and the first important development work carried out in the spring of 1925. Late in the same year the claims were optioned to the Porcupine Goldfields Company who carried on development work throughout the winter of 1925-26 and until the middle of June, 1926, when the property was again visited by the writer. Work has been confined chiefly to the southwest corner of the Matthews claim and, at the time of the last examination, consisted of trenching which involved the removal of 68,000 cubic feet of drift and 8,300 cubic feet of solid rock; diamond drilling amounted to about 5,000 feet. A number of buildings have been constructed and trails and roads have been cut to provide communication with lake La Motte.

The property lies within a zone of Timiskaming sediments penetrated by many intrusive bodies, and which extends from Piché lake northwest to the bodies of granite and syenite in range I, Malartic township. Work done to date on the property has not yet made it possible to delimit the outlines of the intrusives and to establish their relations to the metamorphosed Timiskaming sediments, which make up the greater part of the country rock. The sediments consist of coarse and fine bands which strike about 10 degrees north of west and dip either vertically or at a steep angle to the north. The coarse bands have locally the composition of an arkose or greywacke, exhibit crossbedding in places, and are composed of thin beds which locally attain a thickness of 6 inches. The coarse phase is comparatively little altered. Interbanded with it are bands of very thinly bedded, argillaceous rock. These bands are locally only about an inch thick and the beds forming them may be of paper thinness. All the rocks have undergone some alteration. The extreme degree of alteration suffered by some of the less resistant beds has resulted in the formation of true biotite schist, which occurs in narrow bands within the sediments, but the ordinary type of alteration has resulted in the silicification of the rocks with the production of some secondary biotite and in the shearing of the beds parallel to the bedding. The end phase of silicification has produced veins and stringers of the replacement type in a glistening silicified rock. In part these quartz veins are fissure veins and in part they are replacements of the grains of the sediments. Sulphides accompany the quartz. The quartz veins hold silicified and highly altered, angular fragments of greywacke.

The probable source of this silicification is the porphyry, of which a large boss occurs in the southwest corner of the Matthews claim and the northwest corner of the Kennedy claim which lies to the south of it. Smaller dyke-like masses of the same rock occur southwest of the No. 1 vein on the Matthews claim. The porphyry consists of feldspar phenocrysts, some attaining a length of one-quarter inch, in a groundmass usually light in colour. Phases having a dark-coloured groundmass also occur.

Two principal ore-bodies have been found. The principal showing is the No. 1 vein, 300 feet northeast of the No. 4 post of the Matthews claim. No. 1 vein strikes about 10 degrees north of west and has a dip that varies from 65 degrees north at the east end, to vertical towards the west end. It is exposed for about 100 feet and contains quartz lenses varying in width from 5 feet to a few inches. The country rock is coarse and fine-grained sediments, containing some quartz stringers, and is in places somewhat sheared. A narrow dyke of porphyry parallels the vein about 40 feet to the south. The vein is about parallel to the strike of the sediments and either follows a shear zone or a series of beds that were easily replaceable by the siliceous solutions carrying the ore. The quartz is rather granular and is of glassy appearance. Free gold as well as pyrite, galena, and chalcopyrite occurs in the quartz. Some mica flakes form rosettes within cavities in the quartz. The country rock adjacent to the vein is mineralized, so that including the quartz there is present a mineralized body with a width of about 6 feet and a length of about 100 feet. Assays of samples from the surface indicate that the mineralized body will produce ore that may be mined at a profit. A diamond-drill hole, located north of the vein, intersected at depth a small section of ore that is considered to be the downward extension of this vein. The vein is cut by small, transverse fault-planes along which movement has been slight.

On the strike of this vein, just to the west, the sheared country rock has been considerably replaced and is heavily mineralized by pyrite. Two hundred feet to the west and on the same strike, is a much replaced zone, in places almost pure quartz with some feldspar and a high pyrite content. The sediments here are cut by small stringers of quartz which carry segregations of coarse mica flakes. The greatest width of mineralized rock is 25 feet and the known length 120 feet.

The No. 2 vein lies 400 feet northeast of the main showing of No. 1 vein and 700 feet northeast of No. 4 post of the Matthews claim. It differs from the No. 1 vein in having no wide bodies of quartz. The mineralized part consists of quartz and altered greywacke up to 21 feet wide and with an average width of about 15 feet and a known length of about 100 feet. The mineralization is the same as in the No. 1 vein.

O'BRIEN CLAIMS, CADILLAC TOWNSHIP

The O'Brien claims are in Cadillac township just to the west of the Thompson claims. The southwest group of ten claims, Nos. 1488 to 1497, lies east of Blake river about half a mile north of the east-west centre line of Cadillac township. These claims were staked by the O'Brien Company during the early summer of 1924 and shortly after development work was begun. A winter road was cut from the main road leading from Amos to La Motte and several camp buildings have been erected. An air hoist and motor compressor have been installed. After preliminary trenching and stripping, underground work was begun and late in the summer of 1925 there was completed an 87-degree shaft 110 feet in depth, a drift along the vein 320 feet in length, and a crosscut extending 265 feet northward from the bottom of the shaft. During the winter of 1925-26 and the summer of 1926 twelve diamond-drill holes were bored aggregating approximately 6,000 feet.

The veins on which work has been done outcrop on a low, rocky ridge a few hundred feet north of the La Motte trail. The ridge dips sharply northward beneath the deep drift lying in a depression which appears to be the extension of the drift-filled valley in which is a stream flowing eastward across the Thompson property to join Blake river. This drift-filled depression is considered to be the location of a fault with a general east-west strike. The reasons for this opinion and the significance of this feature will be discussed later. The outcropping strata are Timiskaming sediments, porphyry dykes or sills, and greenstone bands. The general strike of the bands of sediments, the dykes, and the greenstone bodies is about east-west. The southern part of the claims is underlain by altered, banded sediments which vary in colour from grey to greenish. With them are two bands of greenstones. To the north the sediments are cut by a 15-foot dyke of porphyry in which one inclusion of the sediments was noted. The porphyry is apparently intrusive, though no appreciable decrease in grain could be observed near its contact with the sediments. The porphyry, which is much sheared, has feldspar phenocrysts in a feldspathic, green groundmass and has the composition of a diorite. A conglomerate band lies north of the porphyry, is from 50 to 80 feet wide, and has a medium-grained arkosic groundmass with pebbles up to 5 inches in length, some of which are of granitic rock. Some of the pebbles are little sheared, whereas others, often adjacent, are squeezed and drawn out parallel to the direction of shearing. Some pebble-like bodies of a coarse, porphyritic rock appear to have originated as injections from the intrusive porphyry bodies nearby. North of the conglomerate is a band of porphyry 50 feet wide. Near its southern contact the porphyry is highly sheared and is fine-grained, but the grain coarsens a few feet to the north. The feldspar phenocrysts make up about 30 per cent of the rock. Within the porphyry body also, the rock is much sheared and the phenocrysts are oriented in the direction of shear. The porphyry is much oxidized and carbonated, and holds a small vein of dark, glassy quartz from 6 to 24 inches wide. North of this porphyry is a band of dark, igneous, massive rock ranging in grain from fine to coarse, and having the composition of a diorite or basalt. This band varies in width up to 70 feet and is cut by a dyke of porphyry from 10 feet to 20 feet wide. North of this basic rock is the shallow valley presumed to be the locus of a large fault.

The underground workings reveal essentially the same succession of strata as are visible on the surface. Vertically beneath the northernmost outcrop of the basic igneous rock (diorite or basalt), is a layer of fault gouge from 1 foot to 2 feet wide. North of this is a width of 150 feet of much contorted talc-chlorite schist, presumably produced by the intense shearing of the basic rock. A uniform width of this schist was encountered in every drill hole. North of this highly sheared zone the diamond-drill holes are reported to show igneous rock similar to that just south of the shear zone. Drilling in the schist showed the presence of several narrow, dyke-like bodies of porphyry, all somewhat sheared, but one small body little or not at all sheared was reported in the crosscut passing through the sheared zone.

Five principal veins are disclosed by surface and underground work and by diamond drilling. The No. 1 vein, which has a known length of 1,400 feet, lies almost entirely within the conglomerate band. Its strike is slightly undulating, but corresponds fairly closely with that of the conglomerate. Its dip is 87 degrees north. Its width is irregular, ranging from 15 feet to a few inches. Its greatest width occurs at the contact of the conglomerate and the greenstone lying to the south of it. The quartz of the vein is dark and glossy in general, though some sections of white quartz occur within the dark quartz. Coarse, free gold occurs scattered through the quartz at intervals over its entire length. Arsenopyrite is the commonest mineral within the quartz, though some pyrrhotite was seen and a little chalcopyrite is reported to occur. The shaft and main drift have been cut in this vein.

No. 2 vein is of no importance. It is about 1 foot wide and cuts the greenstones near the south of claim 1492. No. 3 vein lies north of the northernmost body of porphyry and is also unimportant.

No. 4 vein occurs within the porphyry 80 feet north of the shaft. It has been uncovered intermittently over a length of about 1,200 feet and follows the strike of the porphyry body. The width of the vein varies between 6 and 24 inches. In one section about 60 feet long it carries a large amount of coarse, free gold in small fissures within the quartz. The adjoining country rock is sheared and near the vein carries some free gold.

No. 5 vein has been encountered only by diamond-drill holes in the sheared zone. The indicated width is between 9 feet at a point 340 feet northeast of the shaft to a mere stringer towards the eastern boundary of the claim. The vein matter is quartz or silicified rock and is mineralized with coarse arsenopyrite.

Values so far encountered are interesting, but erratic. To the north of the zone carrying considerable free gold, evidence of a considerable fault has given the property an attractive speculative value. Diamond-drill holes have been so placed as to pierce this fault zone and assays of sections of the core indicate that within the sheared zone there occur quartz lenses or mineralized zones in which values are found. As in the mineralized veins to the south, values, in some cases considerable, occur, but as yet do not seem to be so consistently disposed as to warrant the opinion that a workable body of ore has been located.

THOMPSON CLAIMS, CADILLAC TOWNSHIP

The Thompson property consists of three claims in the northwest quadrant of Cadillac township. Claim No. 1404 is bounded by the west boundary of Cadillac township. Claim No. 1403 adjoins No. 1404 on the east and is adjoined, in turn, by claim No. 1402. The claims are reached by way of Blake river and a trail which runs westerly along the northern boundary of the claims to the buildings and workings. The claims are square and approximately 50 acres in area. Development work has been confined chiefly to the easternmost claim.

The group was staked in the early part of the summer of 1924 and later was given under option to the Victoria Syndicate and a small amount of development work carried out. During the winter of 1924-25 further work was performed by the Anglo-French Company. By September, 1925, a considerable amount of trenching and other surface work had been completed. Bedrock is now exposed by trenching over a length of about 1,500 feet from east to west and for a distance of about 300 feet from north to south. The overburden is heavy and it has been necessary in many places to dig the trenches to a depth of from 6 to 10 feet before encountering bedrock. In the areas of heavy mineralization, pits have been sunk into the rock for depths of from 6 to 10 feet.

The mineralized areas lie within Timiskaming rocks, about 2 miles south of the Timiskaming-Keewatin contact. The rocks of the vicinity consist of finer sediments with conglomerate and narrow bands of porphyry and what appear to be greenstones interbedded with the sediments.

From 500 to 700 feet north of the rocky area exposed by trenching, is a small creek which flows eastward through a shallow, drift-filled valley to join Blake river near the O'Brien claims. The trend of this depression is approximately east-west and it appears continuous with the depression crossing the O'Brien property. Underground work on the O'Brien claims disclosed that this depression was underlain by a zone of highly sheared rock. Diamond drilling on the Thompson indicates that the depression is here also underlain by a similar rock. It is presumed that this shearing is in the zone of a fault which passes to the north of the areas at present known to be mineralized on both properties. The much crumpled talc-chlorite schist of this zone has a width of probably more than 300 feet, which suggests that the movement in this zone was considerable. It appears also that this fault is about parallel to the strike of the rock formations which, according to the direction of the contacts of greenstone and conglomerate bands, is a few degrees north of east. The general dip of the beds is vertical with the tops of the beds facing south. The sequence of rocks encountered in passing from south to north across the strike of the formations differs somewhat at different points along the strike.

The rocks underlying the southeast corner of the property are greywackes, in which are included some small lenses of conglomerate followed to the north by a lens of conglomerate about 40 feet wide. To the north is a band of dioritic rock which has a width of about 80 feet, as indicated by intermittent outcrops. It is not possible to state definitely whether this dioritic rock is intrusive or a coarse flow. In contact with the diorite to the north is a band of porphyry with an exposed width of 30 feet, within which lies a mineralized zone. To the north is a width of 160 feet unexplored. North of this lies a width of 30 feet of greywacke, considerably sheared. This width was determined by diamond drilling, as much of this section is deeply drift covered. A diamond-drill hole showed to the north of the greywacke a width of about 80 feet of a talc-chlorite schist, followed by a body of diorite-aplite, apparently not sheared, and followed in turn by a zone of talc-chlorite schist about 140 feet wide. About 200 feet to the north there are outcrops of conglomerate and greywacke with an east-west strike and a vertical dip.

Six hundred feet west of the east boundary of the claim and 200 feet east of the section last described, the surface stripping discloses a somewhat similar succession of rocks. From south to north occur: a conglomerate band; a band of diorite 75 feet wide; 25 feet of porphyry; 20 feet of drift; 5 feet of massive greenstone; 50 feet of porphyry, in part considerably sheared along a narrow, mineralized zone. This porphyry and the mineralized zone are the extensions of the 30-foot band from 200 feet to the west. The southern band of porphyry has no equivalent in the eastern section.

A diamond-drill hole close to the northern boundary of the claim and 800 feet west of its eastern boundary passed through, as previously described, a talc-chlorite schist which has within it a body of diorite-aplite or porphyrite about 80 feet wide. This porphyrite is comparatively unaltered. It is white in colour and has scattered through it angular or embayed phenocrysts of plagioclase with a length of 1 to 2 mm. in a fine-grained groundmass, composed mainly of acid plagioclase in minute laths and angular grains. Grains of quartz are scattered through this feldspathic matrix, and many of them are slightly larger than the plagioclase of the groundmass. No coloured bisilicates nor any remnants of them are seen in the rock. A small amount of carbonate occurs. The specimens from the drill-cores show that the rock is massive and not sheared, in which respect it differs greatly from the talc-chlorite schist which surrounds it. The talcose schist has apparently been derived from the intense shearing of basic rocks. It is, therefore, concluded that the diorite porphyrite is intrusive into the schist and later than the movement which caused the shearing.

The two bands of porphyry to the south are much coarser in grain and are highly sheared, and hence probably older than the porphyrite found within the schist. The shearing of the porphyry was probably contemporaneous with the shearing that produced the talc schist. The bands of porphyry are believed to be intrusive, because of their irregularities along the strike as disclosed by trenching. No apophyses or dyke-like masses were found branching from them, though such bodies may exist beneath the extensive drift cover on the property. Carbonate alteration is noticeable in the greywackes close to the porphyry, which suggests that the porphyry is intrusive and brought with it the solutions that contained carbonate.

The greenstones found on the property are schistose in many places, but resemble closely the andesites found within the Timiskaming sediments and observed to be pillowed at roughly the same horizon a few miles to the west.

The zone of mineralization has been traced on the property over a length of 900 feet. It is confined to the northernmost band of porphyry. It has a width of 2 to 6 feet and is almost continuous over the length of 900 feet. The porphyry along the zone is sheared and carbonated and mineralized with sulphides and arseno-sulphides. Within the zone are lenses and stringers of quartz. In the eastern part of the mineralized zone, the quartz attains a width of 4 feet and holds this width for approximately 50 feet along the strike. The quartz is usually dark and glossy, but white quartz is also found. Associated with the quartz lenses and stringers are pyrite, arsenopyrite, and a little pyrrhotite. Free gold occurs within the quartz, locally in considerable amounts. The richest showings are at the west and east ends of the mineralized zones. The rich deposit of the eastern end is located where a minor fault cuts across the vein. In the fault gouge dendritic masses of gold have been deposited. The free gold seems to be confined chiefly to the quartz. No other mineralized zone than that just mentioned has been so far located.

The location by diamond drilling of a fault zone 300 feet wide intruded by a porphyritic rock and within 250 feet of a well-mineralized zone is of considerable interest and indicates that the property is one which merits the expenditure of a considerable sum to determine its value.

MONTREAL EXPLORATION COMPANY CLAIMS, BOUSQUET TOWNSHIP

The claims of the Montreal Exploration Company lie in Bousquet township about 1½ miles west of mile-post VII on the east boundary of the township. Development work on them has been carried on by Mr. H. L. F. Blake. The overburden is extensive and in some places deep, so that much trenching has been required. Over 2,000 feet of trenching has been done, with rock cutting as required for sampling. Surface work has been done on claims A232, A233, A234, A235, A240. The principal work has been done on claim A235.

The claims are underlain by Timiskaming rocks. The depression which crosses the O'Brien and Thompson claims apparently passes through this group. The shallow valley is occupied by the same eastward-flowing stream, but the drift is too heavy to determine if a similar zone of sheared rock underlies the valley. The strike of the formations is practically east-west. The southern parts of claims A234 and A235 to a line about 400 feet north of the southern claim line is underlain by a coarse feldspar porphyry, much sheared in many places. To the north is a band of basic lavas about 200 feet wide. Within these lavas are some well-developed pillows. North of the lavas fine sediments with some conglomerate occur over a width of 150 feet, beyond which a heavy drift cover extends to a point 600 feet north at the northern boundary of the claim.

A mineralized zone lies within the volcanics just south of their contact with the sediments. It consists of an irregular, shattered zone bearing quartz and carrying some sulphides and some values in gold, but is not in itself important. The mineralization and the probability of locating the O'Brien fault just to the north, make it seem advisable to diamond drill the mineralized zone and to pierce the fault zone at some depth, in search of a mineralized zone within the faulted area.

MOLYBDENITE AND BISMUTHINITE

Occurrences of molybdenite are not now being worked to any extent within the region. Some prospecting was carried out in the period about 1911, and in 1918 a serious attempt was made to produce molybdenum from the deposits in Preissac township. At the conclusion of the war, the market for this product declined and work on the Kewagama Lake properties was abandoned immediately after a plant had been erected for the separation of the molybdenite. In later years some work has been carried out by the Molybdenum Reduction Company on a property in the southeast corner of LaCorne township, but no extensive plant has yet been erected. Testing of mill samples of the ore indicates that a marketable product may be obtained from the veins now exposed. The future of molybdenum production in the region will probably depend more on the development of a market to absorb the product than on any other factor.

The molybdenite occurrences in the vicinity of Kewagama lake were examined in 1911 by J. A. Bancroft for the Quebec Department of Mines, and are fully described in his report for that year. On these properties the trenches have caved and underground workings have filled with water.

The Molybdenum Reduction Company holds claims in the southwestern corner of LaCorne township and in the northeast corner of Malartic township. These claims were fully described by Mailhiot in the "Report on Mining Operations in the Province of Quebec for 1919." Some work has been done on the claims since that time.

Bismuthinite occurs in small quantities, associated with some of the molybdenite occurrences, and is noted in the reports referred to above.

CERTAIN MINERAL DEPOSITS IN DESMELOIZES AND TRÉCESSON TOWNSHIPS, QUEBEC

By W. F. James and J. B. Mawdsley

DESMELOIZES TOWNSHIP

In the middle of October, 1925, a visit was made to a property in Desmeloizes township, Quebec, under option to the Canadian Exploration Company of Amos, Quebec. The property includes 800 acres and comprises, in range X, the south halves of lots 38 to 42 inclusive, all of 43 and 44, the south halves of 45 to 49 inclusive, and, in range IX, the north halves of lots 46 and 47.

The property lies 11½ miles due north of Dupuy, on the Canadian National railway, 8 miles east of the Ontario-Quebec boundary. From Dupuy there is a good automobile road for 2½ miles, beyond which a winter road 9 miles long has been completed to the property.

The mineralized showings on the property are on the south slope of a low ridge, which in part is bare rock, and extends in the vicinity of the property east and west through the centre of range X. To the south of this ridge the country rapidly declines into a drift-covered stretch with few outcrops.

At the time of the visit the company had completed a series of trenches on the south slope of the ridge 1,000 feet from the south boundary of lot 45, range X. These trenches, 20 to 40 feet apart, exposed an area 250 feet in length in a northwest and southeast direction, and having a width of approximately 60 feet. Extending north-northeastward from this trenched area is a trench 700 feet long disclosing much bedrock. Southeast by east of the main trenched area, at a distance of about 800 feet, are two trenches which penetrate the heavy overburden on what was believed by the operators to be the extension of the main mineralized zone, and expose the bedrock.

The rocks exposed by the trenching are of Keewatin age, with the possible exception of a porphyry which may be intrusive and later in age. The Keewatin is made up of volcanic flows of varying composition, but usually intermediate or andesitic in nature. Interbedded with them are some banded sediments, probably waterlain tuffs. These various rocks are typical of great areas of the Keewatin in Quebec. The flows and sediments have a strike of probably close to 30 degrees north of west, and their dip is vertical.

The porphyry forms the southwest wall of the mineralized zone and may in fact form much of the altered country rock within the zone. The porphyry is much sheared near the mineralized area and if it were not possible to trace it from the less sheared to the more sheared areas it would be difficult to recognize it in the zone of shearing. The porphyry is essentially a green rock with eyes of quartz and light-coloured phenocrysts of altered feldspar. Where only slightly sheared it is composed of 15 per cent or so of phenocrysts of quartz up to 1 mm. in diameter. Many of these phenocrysts show an idiomorphic form. Where crushing has been intense the phenocrysts also are crushed and converted into strung-out particles of quartz. The feldspar phenocrysts have been completely altered and have suffered granulation to a greater extent than the quartz phenocrysts. No original ferromagnesian minerals are recognizable and the feldspar and groundmass are now a mass of secondary minerals, of which chlorite and carbonate are the most important. The impression is that this porphyry is probably a volcanic flow, but no definite evidence has been obtained.

The mineralized area is exposed in the main series of trenches and at the time of visiting the property was exposed over a length of more than 200 feet and a width of from a few feet at the northwest to about 60 feet at the southeast. The mineralized area is composed of much altered rocks which originally were probably quartz porphyry or volcanics of unknown composition, but are now strongly carbonated and sheared, and in places silicified. The shearing is vertical and has a strike of 140 degrees. Within this area are four mineralized zones striking from 130 degrees to 140 degrees, dipping vertically, and separated from one another by areas of barren or slightly mineralized rock.

One zone lies at the southeast corner of the general mineralized zone. It contains two bands of solid chalcopyrite and pyrite, 1 and 2 feet wide, respectively, and separated by 3 feet of disseminated pyrite and chalcopyrite. Some quartz stringers are associated with the sulphides. This zone narrows considerably northwesterly along the strike. In a trench, 60 feet away, a little disseminated pyrite and chalcopyrite is all that is visible and in a trench at 80 feet along the strike no mineralization has been encountered.

The second and most important mineral zone is about 20 feet southwest of the first and is exposed northwesterly in various trenches for 140 feet and 80 feet farther northwest a mineralized mass is found which probably is a continuation of the same zone. The zone over the distance of 140 feet swells and pinches from a width of 4 to 10 feet. Within it are bands of nearly solid sulphides. The best cross-section shows a band 1½ feet wide of sphalerite with a little pyrite intermixed. On one side is a band of nearly equal width formed of 50 per cent chalcopyrite and 50 per cent glassy quartz, and on the other side is a 2-inch band of solid pyrite. In the southeasternmost trench a 6-inch band of disseminated sphalerite is also present. The rest of the 8 or 10 feet making up the zone is formed of bands of silicified and sheared quartz porphyry and greenstone containing a small amount of disseminated pyrite. Along the strike of this mineral zone the mineralization in places is represented by disseminated sphalerite, chalcopyrite, and pyrite developed over a width of 4 to 5 feet. A little galena was seen in a couple of places.

A third mineral zone occurs in the southeasternmost trench, southwest of the second-mentioned zone. This third zone is of minor importance and is visible only in the most southeasterly trench, where it is represented by 1 foot of solid pyrite. In the same trench, 12 feet farther southwest, is the northeastern edge of the fourth mineral zone, there exposed over a width of 8 feet. Its continuation is revealed in cross trenches to the northwest over a distance of 160 feet. It narrows progressively in this direction to where it is not more than 2 feet wide. The gossan top of this mineralized band had not been removed when the property was examined. Very probably the chief mineralization is pyrite.

The country rock lying between the last three mentioned mineral zones is very probably porphyry sheared beyond recognition to a quartzose sericite schist, high in carbonates, light grey in colour, with a silky lustre on its partings. Between the first and second mineral zones, the country rock towards the southeast is a sericite schist, probably originally a porphyry. Towards the northwest the country rock is a greenstone, which in places shows little shearing.

The two trenches, 800 feet to the southeast of the main strippings, are 50 feet apart and in both is visible a sheared zone which strikes 10 degrees south of east in the northwesternmost trench and 27 degrees south of east in the most southeasterly trench. In the northwesternmost trench the mineralization consists of a band 4 feet in width, composed of 50 per cent of pyrite and of contiguous bands 4 and 8 feet wide of disseminated pyrite. In the southeasternmost trench, 50 feet away, the mineralization consists of a little pyrite and a few quartz stringers. The country rock is a chlorite schist.

Although assays have been reported showing in some cases values in gold and in others, values in silver, the chief and essential values are in the base metals. The showings in the main strippings become progressively more interesting as the low ground is approached. Whether mineralization increases below the heavy drift of the low ground is a matter of pure conjecture. It is not certain that the mineralization in the trenches 800 feet southeast of the main strippings is related to the mineralization found in the main showings. If further work is deemed advisable, the position for it is in the low ground adjacent to and southeast of the main showings.

TRÉCESSON TOWNSHIP

Lots 2 and 3, range 5, Trécesson township, Abitibi county, Quebec, comprise the prospect worked during the past few years by John Chenier of Vilmontel, Quebec. The prospect is ½ mile north and 2½ miles west of Vilmontel village, and is easily reached by a good road, which in the vicinity of the property follows the west boundary of lot 1. Two ridges cross the southern part of the lots upon which the claims are located. The northern ridge runs slightly north of west and is entirely of greenstones, showing pillows in most places. This ridge extends across lots 1, 2, and 3. South of its eastern end is another prominent ridge, 500 feet wide, and extending due east and west across lots 2 and 3. This ridge is of the peridotite in which asbestos veinlets occur. To the southeast and in part to the north, the country is heavily covered with drift, mostly glacial lake clays and sands.

It is believed, but not definitely determined, that the peridotite mass is intrusive into the Keewatin greenstones. Veinlets of asbestos were seen in various parts of the peridotite mass, mostly in association with serpentine. The greatest number of veinlets are in a basic phase of the mass which forms the southern edge of the peridotite ridge. The asbestos veinlets are few and scattered and do not average more then one-quarter inch in width. A little slip fibre a couple of inches long is found along some of the minor fault-planes. Present showings do not indicate that there is on these claims a deposit of asbestos of economic importance.

28737—6½

DESTOR AREA, ABITIBI COUNTY, QUEBEC

By B. S. W. Buffam

CONTENTS

Illustrations

INTRODUCTION

Destor map-area is about 16 miles due south of La Sarre on the Canadian National railway and extends eastward from the Ontario-Quebec boundary for 40 miles. It includes parts of the townships of Hébecourt, Duparquet, Destor, and Aiguebelle, and covers an area of about 235 square miles.

The area is readily accessible by canoe route from La Sarre or La Reine on the Canadian National railway. A motor launch runs to Danseur portage on Abitibi river and from there any part of Hébecourt or of Duparquet can be easily reached. The Makamik road, nearing completion during the summer of 1925, will provide a means of motor transport to Rouyn and serve as a convenient route to the central part of the area. Farther east the railway, at present under construction from O'Brien to Rouyn, crosses the eastern boundary of Destor and will, when finished, eliminate the present canoe route via Robertson and Lois lakes to the eastern part of the area.

With the exception of work done by Messrs. Wright and Segsworth who, in 1924, examined the area in a general way, no detailed mapping had previously been attempted. Reconnaissance of the geology along the waterways was all the published information available. This work included an account of the Timiskaming-Abitibi canoe route and of the shores of lake Abitibi by Walter McOuat, the canoe route from Duparquet lake to Dufresnoy lake by J. F. E. Johnson, and a more elaborate account of the whole region by M. E. Wilson in his two Memoirs, 39 and 103.

The following report describes a geological examination carried out during the field season of 1925. The object of the investigation was to trace, delimit, and, if possible, determine the structural position and age of a band of sedimentary rocks which Wright and Segsworth[1] had described as being similar to those occurring in Porcupine. In addition, the rock exposures in the area were to be mapped in greater detail than had hitherto been attempted.

[1] Wright, D. G. H., and Segsworth, W. E.: Engineering and Mining Journal Press, vol. 117, p. 763 (1924).

The writer wishes to express his appreciation for the assistance and information which he so readily received in the field from the following: Otto Berner, Eugene Bachmann, Kellar Bros., and the fire rangers on Dugros lake, Duparquet lake, and at Danseur portage.

During the summer J. B. Mawdsley mapped 50 square miles in northern Aiguebelle and with his permission an account of that area has been included in the present report. To Messrs. James and Mawdsley and to the members of the Department of Geology, Princeton University, the writer is indebted for advice and assistance in the field and for help received during the preparation of this report.

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GENERAL CHARACTER OF THE DISTRICT

PHYSIOGRAPHY

Destor map-area may conveniently be subdivided, physiographically, into two divisions: (*a*), the rocky uplands and (*b*), the relatively flat, clayey lowlands. The first division includes Aiguebelle, Destor, the eastern part of Duparquet, and the western part of Hébecourt townships. These are areas of considerable local relief and are characterized by hills and ridges, which have an east-west trend, and elevations of 150 to 200 feet above the intervening valleys. The ridges have abrupt rocky faces to the north and more gentle slopes southward, usually covered more or less thickly with coarse glacial drift.

The second physiographic subdivision, the clayey lowlands, includes principally that part of the area extending east and west for 5 miles on either side of Abitibi river in the townships of Duparquet and Hébecourt. This part of the area is low and flat. It is covered by thick deposits of clay and sand, in which numerous small creeks have cut narrow gullies to depths of 20 to 30 feet. In Hébecourt, especially, this lowland area is overgrown with scrub maple, hazel, raspberry bushes, and other low shrubs which, combined with a large amount of fallen timber, makes prospecting a difficult undertaking. The outcrops of rock projecting through the clay are mostly low and widely separated. The total rock exposed is about 10 per cent of the area. East of Duparquet lake and in the northwestern part of Destor there are two smaller areas of flat-lying land that shows the characters of lowland topography.

" The Abitibi district lies somewhat below the general elevation of the surface of the Laurentain plateau, having an average height of from 900 to 1,000 feet above sea-level with hills and ridges rising here and there to elevations from 500 to 700 feet above the surrounding country."[1] Within Destor area the highest elevations occur in Aiguebelle and Destor townships. South of the east-west centre lines in Duparquet and Destor, near the boundary between the two townships, there are a number of relatively high hills which have resulted from the erosion of a syncline of a sedimentary series of rocks. West of reference plate 27 of the Makamik road, a relatively high ridge extends to the eastern boundary of Duparquet township and from the western end of this ridge a comprehensive view of the district to the west may be obtained. Immediately in front the country drops off rapidly to the lowlands along Abitibi river and in the distance, to the west and northwest, Duparquet and Abitibi lakes can be seen.

The only river of importance is Abitibi, which flows north from Duparquet lake and drains about two-thirds of the region described in this report. The subsidiary drainage consists of numerous small creeks, along which both meanders and cut-offs are common. The most important of these smaller streams is the Dalembert, which drains Dalembert (Sills) lake and flows west across the southern part of Duparquet township. This creek occupies a valley about 1½ miles wide and probably represents a preglacial river of much greater volume. At present it is not navigable on account of numerous log jams, but if these were cut out the stream would afford a good canoe route from Duparquet lake to Rouyn, thereby eliminating the present longer journey via Makay, Destor, and Dufresnoy lakes.

Dalembert river flows in a general direction parallel to the structure of the underlying rocks and forms the most southerly member of four such structural valleys developed in Duparquet township. These valleys are as follows: (*a*) Dalembert, (*b*) the depression occupied by Dugros, Makay, Destor lake and river, (*c*) Lanaudière river, which cuts across the synclinal structure of the sediments at right angles, (*d*) Deguisier river. Elsewhere the creeks show less pronounced relations to the structure of the underlying rocks.

Wilson[2] has classified the lakes of Timiskaming region as follows:

(1) Those whose form is not controlled primarily by the underlying bedrock surface, but by the glacial drift deposited upon the bedrock surface.

(2) Those which occupy structural basins, that is, basins whose form is primarily controlled by the structure, foliation, bedding, etc., of the underlying rock.

(3) Those bodies of water whose form is controlled primarily by long, narrow, gorge-like depressions which have been incised in the bedrock surface regardless of its structure (linear valleys).

(4) Those which occupy wide, shallow depressions, having a most irregular outline and containing numerous islands.

The majority of the lakes in Destor map-area are small, and of the twenty mapped, thirteen are less than three-quarters of a mile in length. They belong principally in classes (1) and (2) above or combinations of these two classes. The only linear valley is represented by Eileen, High Cliff, and Clearwater lakes in the extreme eastern part. These three lakes occupy parts of a very deep gorge which cuts across the structure of the volcanics at right angles to the east-west trend of the bedrock.

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[1] Wilson, M. E.: "Kewagama Lake Map-Area"; Geol. Surv., Canada, Mem. 39, p. 14.
[2] Wilson, M. E.: "Timiskaming County, Quebec"; Geol. Surv., Canada, Mem. 103, pp. 23 and 31.

The two largest bodies of water are Duparquet and Hébecourt lakes. They are typical representatives of class (4) above, i.e. lakes which occupy wide, shallow depressions with irregular outlines and a large number of islands. Previous to the advent of the continental ice-sheet and the deposition of the morainal material and later lacustrine clays and sand, it is probable that these two lakes were contiguous. At present they are separated by a low, swampy clay flat through which Hébecourt river flows in a very sinuous course for a distance of about 5½ miles.

Areas of muskeg are small and relatively unimportant. The largest is about one mile long and one-quarter mile wide and is situated between Hébecourt and Bayard lakes. Near the northern boundary of Duparquet township where the country is prevailingly low and flat there are a few small muskegs which probably increase in size northward.

THE CONTINENTAL ICE-SHEET

The formation of outwash plains, moraines, etc., and the deposition of lacustrine clays have been the principal ways in which the preglacial topography has been modified. In many places the irregularities in the surface have been obliterated, and especially along Abitibi river the thick clays completely hide the underlying topography. In Destor and Aiguebelle, where the relief is greater and the general elevation above sea-level higher, coarse, unassorted, morainal material has been dumped in the valleys, largely on the southern flanks of the ridges.

Such forms of glacial topography as kames, drumlins, etc., are not common, but there are numerous sand-plains which possibly represent outwash from the retreating glacier. The largest of these plains lies 2 miles west of the east boundary of Duparquet and extends along the east-west centre line of that township for 2 miles. Another extensive sand-plain is in the northern part of the same township, west of the north-south centre line. A few small kettle-holes, now the sites of small lakes, were observed in Duparquet and Destor. One of these little lakes is situated about one-half mile west of reference plate 23 on the Makamik road and on its western margin there are two raised beaches which can be traced for a distance of a quarter of a mile.

The only disturbance that the glacial deposits have suffered has been the washing bare of the ridges and the trenching of the clays by the numerous small streams, many of which have cut deep courses in this easily eroded material. It is remarkable how little lateral erosion has taken place, in this respect indicating the relatively short period of time that has elapsed since the retreat of the glacier. Where the gradient of a stream is slight, as in the case of Hébecourt creek, an intricate series of meanders has been developed and the banks of the stream instead of being high, as they are where the gradient is greater, are very little above the normal level of the river.

In the area no section of stratified clays was seen. In trenches along the Makamik road peat, in many places as much as 6 feet thick, rests on material which varied from coarse moraine to fine clay and sand.

AGRICULTURAL POSSIBILITIES

The lowland or clay belt along Abitibi river and east of Duparquet lake will some day prove to be a good farming country. At present there are, in this belt, only two settlers south of Abitibi lake, one in Palmarolle and the other in Duparquet just south of the northern boundary of the township. Elsewhere in the map-area regions suitable for agriculture are small, as they are largely dissected by ridges and irregular hills of coarse glacial deposits.

GENERAL GEOLOGY

GENERAL STATEMENT

The Keewatin (Abitibi) group, the oldest rocks in the district, underlie five-sixths of the total area. This group consists largely of volcanic flows, mainly meta-andesites, though in a few restricted areas more basic meta-basalts are abundant. Rhyolitic flows are negligible in amount. In the vicinity of Hébecourt lake dacites, possibly grading into trachytes, form the largest single unit of acidic intermediate extrusives. A highly schistose contact zone immediately south of the granite batholith of Palmarolle is largely composed of dynamically altered Keewatin flows. Tuffs and other pyroclastic rocks are common in the form of narrow bands between the flows, but their area is less than one-half of one per cent of the total map-area.

Basic intrusive sills injected between these surficial rocks and almost contemporaneous in time with their extrusion are believed to be common. They have not been differentiated on the accompanying map since their recognition is difficult because of their similarity in composition, texture, and structure to the thick, massive flows. Apparently the only satisfactory basis upon which they may be differentiated from the extrusives is the more symmetrical texture exhibited by the sills, produced by approximately similar conditions of cooling at both top and bottom of sills, whereas in the case of flows more rapid cooling took place at the surface, thereby developing thick, fine-grained tops and central parts coarser near the bottom. Without patient detailed examination of favourably exposed rock sections this distinction cannot be readily recognized.

Following the cessation of igneous activity, as represented by the more usual Keewatin volcanics, red feldspar porphyry and quartz porphyry were intruded as dykes or sills, or possibly in some places extruded in the form of thick flows. A time interval then ensued sufficient to develop in situ a conglomerate intimately associated with these masses of porphyry and mainly composed of boulders of porphyry. This " porphyry " conglomerate was then buried by the deposition of a conformable series of sediments, consisting of a thin bed of slate followed by arkose, quartzite, and conglomerate, interbedded with arkose. Among the cobbles and pebbles of this later conglomerate are representatives of a great variety of rocks including granite, syenite, andesite, feldspar porphyry, rhyolite, and red jasper. All these pebbles are well rounded and in shape the majority are flattened ellipsoids.

It is not definitely known whether the Keewatin series was folded previous to the deposition of the sediments. It is possible the Keewatin had suffered slight tilting because overturning of the volcanics was observed in Destor up to 15 degrees, whereas the sediments though they are vertical in many places are not known to be overturned. The period of major folding took place subsequent to the deposition of the sediments and it infolded them with the members of the Keewatin group. This great mountain-building was accompanied or followed by the intrusion of a batholith of granite, now exposed on the northern boundary of the area. At possibly a somewhat earlier date than the intrusion of the granite, there were intruded numerous bodies of gabbro and a few isolated masses of wehrlite. The former are exposed in the vicinity of Duparquet lake and the latter in eastern Destor. The granite was later cut in various places by irregular masses of fine-grained quartz porphyry and grey feldspar porphyry. The fine-grained quartz porphyry in eastern Destor was in turn cut by lamprophyric dykes and these small dykes represent the final igneous activity associated with the batholithic intrusions.

The region, in common with the adjoining areas, was then eroded so deeply that the covering over the granite batholith was swept away, the granite itself deeply eroded, and over the whole region a surface of low relief was produced. It is known from neighbouring areas, by a study of the surface upon which the Huronian sediments were laid down, that this planation was largely accomplished prior to the Huronian period.

There is no evidence in the area to indicate whether the Cobalt series ever extended this far north. The nearest sediments of this age are exposed 20 miles to the south in the townships of Dasserat and Boischatel, where they lie flat. But a cessation of erosion probably occurred during the marine invasion in the Ordovician and Silurian periods. Hume writes " It thus seems certain that the formation of the early Silurian age in Timiskaming area is part of a faunal province belonging to an Arctic invasion which extended as far west as Saskatchewan and in the south included the northern peninsula of Michigan and part of Wisconsin. This then represented an inundation of considerable magnitude. . . ."[1] No sediments of Palæozoic age now occur in the map-area.

[1] Hume, G. S.: Geol. Surv., Canada, Mem. 145, pp. 33.

Table of Formations

Quaternary	Post-Glacial	Lacustrine clay and sand
	Glacial	Sand, gravel, and boulders
	Great unconformity	
Pre-Huronian	Pre-Huronian intrusives	Lamprophyre Pegmatite Grey feldspar porphyry Quartz porphyry Granite porphyry Granite Peridotite (wehrlite) Older gabbro
	Folding	
	Timiskaming series (?)	Conglomerate, with jaspilite pebbles Arkose, with lenses of interbedded conglomerate Slate "Red feldspar porphyry" conglomerate and "quartz porphyry" conglomerate
	Unconformity	
	Pre-Timiskaming (?) intrusives	Red feldspar porphyry and quartz porphyry
	Intrusive contact	
	Keewatin	Basalts, andesites, dacites, rhyolites, and tuffs

KEEWATIN

Keewatin rocks underlie the greater part of the map-area and in most respects are similar to the volcanic rocks in adjoining areas. They are composed of flows predominantly intermediate in composition, with which are associated narrow bands of volcanic breccia and a few beds of finely laminated tuff. Adjacent to the granite and along the southern edge of the belt of sediments lying in the middle of the area the Keewatin volcanics are schistose, but away from these localities the flows, though vertical and in many places overturned, are very massive even at the contact between individual flows where movement is usually excessive during folding.

Basic and Intermediate Lavas. Rocks of a basaltic composition occur chiefly immediately north of the sediments in the eastern part of Duparquet township and in northwest Hébecourt. They are darker than the more widespread andesites and have not so extensive a development of ellipsoidal structure. In texture they are medium to fine grained, and are not typically porphyritic.

The widespread andesites are normally rusty red on weathered surfaces and dark grey or green on fresh surfaces. The grain may be coarsely crystalline and show ophitic structure at the centre of a flow, whereas nearer the top and bottom it is usually dense. Ellipsoidal structures are everywhere characteristic of these extrusives and the individual pillows are in many cases 6 or 7 feet in length.

In eastern Destor and in Aiguebelle townships there is a body of highly porphyritic lava, 12 miles in length and about 300 feet in width, which appears to be a single flow. It crosses the Destor-Aïguebelle boundary about 2 miles south of lake Lois. Due to its striking and exceptional appearance it is readily recognized in the field. The flow has a dark grey, usually dense matrix, in which occur many whitish to light olive-green phenocrysts with a dull, greasy appearance. These phenocrysts vary in size from an average diameter of $\frac{1}{4}$ inch up to 3 inches. Crystals of this unusual size occur plentifully in that part of the flow exposed west of the north-south centre line of Destor. Here the crystals increase progressively in size from south to north, i.e. from the top of the flow towards the bottom. In Aiguebelle the flow, 300 feet in thickness, has crystals ranging from $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter in a fine-grained matrix which shows ellipsoidal structure. Microscopically the matrix of the rock is composed of minute, more or less equidimensional particles, 80 per cent of which are epidote; the others include a few, scattered, rounded grains of quartz and a little clear feldspar (plagioclase). The large feldspar phenocrysts though retaining perfect idiomorphic outlines and traces of faint zoning are completely saussuritized and their original composition is entirely masked.

In Hébecourt township another distinctive flow was encountered. In this instance the flow is a spherulitic lava similar to the one described by Burrows[1] in the Porcupine gold area. The flow has an approximate length of 3 miles, but because of the vegetation and the heavy mantle of drift it is less well defined than the porphyritic flow above described.

The observed thickness of the flows in the area varies from 3 feet up to 300 feet. East of reference plate 26 on the Makamik road a section of twenty-two flows of andesitic composition was noted. Twenty of the flows have a total thickness of 515 feet. They are all very similar in appearance and it is probable that they do not differ greatly in chemical composition.

Acid Lavas. In Destor map-area volcanic rocks more acidic in composition than andesites are rare and quantitatively unimportant. In eastern Destor near mile-post 2 on the east-west centre line there is exposed a highly schistose rhyolite. It outcrops over an area $1\frac{1}{2}$ miles long and 800 feet wide and over this area the prevailing direction of the schistosity is north 60 degrees east, dip vertical. In a few places where the rhyolite has remained massive it is characterized by flow structure and a peculiar ropy and scoriaceous appearance, in other parts it is porphyritic with phenocrysts of quartz and feldspar up to 4 mm. in diameter. Whether this rhyolite represents one or more flows was impossible to determine because of the highly schistose character of the rock.

West of Dufresnoy lake rhyolite forms a high ridge $\frac{3}{4}$ mile in length and 500 feet wide. Flow structure is very well developed and strikes from

[1] Burrows, A. G.: Ont. Bureau of Mines, Ann. Rept., vol. 33, pp. 16.

north 80 degrees east, to north 80 degrees west, and in places resembles small pillows 4 inches in length. This rhyolite is also schistose, the strike of the schistosity being north 90 degrees east, dip 80 degrees south.

Volcanic Breccia. In many parts of the area it is common to find beds or bands of coarsely fragmental rock intercalated between the flows. These fragmental rocks are usually 3 to 10 feet thick and are composed of angular or subangular fragments up to 6 inches in diameter and more or less acidic in composition, set in an andesitic matrix. This matrix is generally massive, fine-grained, and without noticeable bedding. Typical examples of this rock occur ½ mile south of lake Lois and on island 37 in Duparquet lake. Many of the flows near their tops grade upwards into flow agglomerates which on weathered surfaces resemble somewhat the fragmental rocks described above, but the matrix shows distinct flow structure and the fragments cannot be distinguished from the matrix on fresh surfaces.

Tuffs. Fine-grained tufaceous rocks are uncommon and with the exception of a narrow band in central northern Destor and slate and phyllite exposed on the northern shore of Duparquet lake typical laminated tuffs of undoubted Keewatin age were not observed. Slate and phyllite outcrop on the shore of Duparquet lake near the mouth of Abitibi river and inland for about ½ mile along the township-line between Hébecourt and Duparquet. They have a width of approximately 2,000 feet in a north and south direction, dip practically vertical, and strike north 65 degrees east. They are finely laminated, the beds varying from a millimetre to 1½ cms. in thickness, and black to light grey in colour. The beds have been highly metamorphosed and a thin, slaty cleavage developed. Because of the heavy overburden inland only small, isolated outcrops were found, but it is likely that these rocks extend at least 1½ miles eastward. The beds are considered to have been deposited largely as tuffs in late Keewatin time, since no unconformity between the flows and the slate could be found and the strata lie along a major synclinal axis and are, therefore, relatively near the top of the members forming the syncline. This deposit stratigraphically near the top of the Keewatin is analogous to the thick band of tuffs exposed 24 miles to the south and described by H. C. Cooke[1] in his report on Opasatika map-area.

Carbonate Rock. The volcanic rocks when examined under the microscope are found to contain a high percentage of secondary carbonate. This is a condition common throughout the Timiskaming region and has been considered by Wilson[2] to be due to metasomatic action more or less contemporaneous with the cooling and consolidation of the lava. Local more intense carbonatization has taken place in the volcanics south of the band of Timiskaming sediments, along a sheared zone extending from the Makamik road to Duparquet lake. In this carbonated zone the rocks are characterized by rusty, red-weathered coatings, 2 to 3 inches deep, and

[1] Cooke, H. C.: Geol. Surv., Canada, Sum. Rept. 1922, pt. D, p. 30.
[2] Wilson, M, E.: Geol. Surv., Canada, Mem. 39, pp. 55.

light yellowish, fresh surfaces, Ramifying irregularly throughout are narrow stringers of milky white quartz. The principal carbonate present is ferruginous dolomite associated with minor amounts of siderite and calcite.

PRE-TIMISKAMING INTRUSIVES

Red Feldspar Porphyry. A large mass of purplish-red feldspar porphyry is exposed in Duparquet township close to the east-west centre line. This body of porphyry has a length of 3 miles and a maximum width of $\frac{5}{8}$ of a mile. It extends from $\frac{1}{2}$ mile east of the north-south line to within $\frac{1}{2}$ mile of Duparquet lake. In addition to this large mass a few small dykes of reddish porphyry were observed intrusive into the volcanics $1\frac{1}{2}$ miles to the east, and also to the south, of the sedimentary series, adjacent to the Destor-Duparquet boundary. A megascopic and microscopic similarity seems to indicate that the smaller intrusions are of the same age as the large body of porphyry.

The rock is highly porphyritic, with phenocrysts of feldspar up to 1 inch in diameter. These phenocrysts have good crystal form and vary in colour from grey or green to pink, depending upon the amount of alteration that they have undergone. The matrix is variable as regards texture, but is usually fine grained and under the microscope is found to be composed of a felted aggregate of small plagioclase and orthoclase laths with indistinct outlines and generally much altered. The alteration products developed are small patches of carbonate, flakes of sericite, and occasionally a small, irregular grain of epidote. All the phenocrysts are clouded with kaolin and flakes of sericite. Pyrite and magnetite in small grains and crystals are common. The composition of the feldspar phenocrysts as determined by oil immersion is anorthoclase.

Alteration of the porphyry has been particularly intense east of the north-south centre line. Here the rock is light green and is cut by a network of small stringers of milky white quartz, which carry finely crystalline galena, tetrahedrite, chalcopyrite, and arsenopyrite. The porphyry has been mashed and rendered schistose over considerable areas and near the western end of the large mass, silicification and mineralization have occurred along a number of these sheared zones.

Quartz Porphyry. In the central part of the area within and near the synclinal area of Timiskaming sediments numerous apparently small bodies of quartz porphyry outcrop. This porphyry is characterized everywhere by a light olive green to light grey, aphanitic groundmass in which are scattered a large number of conspicuous phenocrysts of quartz usually $\frac{1}{10}$ to $\frac{1}{2}$ inch in diameter and an occasional crystal of mica, diameter $\frac{1}{10}$ inch, now completely altered to chlorite. A highly porphyritic grey feldspar porphyry is also present and is considered to be a phase of the quartz porphyry. It holds in addition to a multitude of square to tabular feldspar crystals up to $\frac{1}{5}$ inch in diameter, many glassy phenocrysts of quartz similar to those in the normal phase except that they are seldom as large. The porphyry is schistose in some places as the result of the folding that it has endured. No flow structure or regular orientation of the crystals was observed.

Under the microscope the groundmass consists of a cryptocrystalline, feldspathic aggregate which contains a multitude of minute sericitic flakes as an alteration product. Scattered throughout this groundmass are clear crystals of quartz, more or less rounded in form, and a large number of smaller, highly altered phenocrysts of feldspar which by their angle of extinction were determined to have an approximate composition of $Ab_{87}\ An_{13}$. A few crystals that were untwinned or simply twinned according to the Carlsbad law are possibly orthoclase. The alteration of the feldspar phenocrysts has been similar to that of the groundmass and small flakes of sericite and paragonite in many cases make up 75 per cent of the former crystal. Small grains of pyrite and black iron ore, as well as a few, small, irregular patches of chlorite, are scattered throughout the rock.

A small area of quartz porphyry lies adjacent to the southern edge of the Timiskaming strata where it crosses the boundary between Destor and Duparquet townships. Quartz porphyry again outcrops 560 feet north of this within the area of Timiskaming strata and here in a trench 6 feet wide is the only visible contact between the Timiskaming sediments and the porphyry that was found. This contact is very sharp and the arkose lying against the porphyry shows no metamorphism nor change in grain or structure. The quartz porphyry also remains unchanged, showing no chilled edge and large phenocrysts of quartz and feldspar up to $\frac{1}{5}$ inch lie against the arkose.

Several other outcrops of quartz porphyry occur within the band-like area of Timiskaming sediments and hold positions that might be considered to indicate that the porphyry was contemporaneous with or intrusive into the sediments, but in view of the relations observed to hold at the above-mentioned locality where the actual contact of the porphyry and sediments is visible, it is considered that all these bodies of igneous rock are older than the sediments. The porphyry outcrops are elongated parallel to the axis of the synclinal area of Timiskaming strata and it is thought that the positions of the porphyry exposures indicate that the igneous rock and the overlying sediments have been closely folded and that erosion has laid bare the porphyry along the axes of minor anticlinal folds.

The red feldspar porphyry and the quartz porphyry are presumably closely related in origin and date of formation. Some of the masses of these rocks are narrow, elongated dyke-like, but the main body of the red feldspar porphyry is broad. Though most of the occurrences lie along the axial part of a major syncline, some lie a considerable distance to the north. It may be that the large body of red feldspar porphyry is a sill or a flow which lay towards the summit of the Keewatin and that the smaller bodies are dykes or small stock-like bodies. In any case a seemingly unavoidable conclusion is that the porphyry masses are younger than the bulk, if not all, of the more usual Keewatin volcanics.

TIMISKAMING SERIES

The sedimentary rocks in the area, which are tentatively correlated with the Timiskaming, are well exposed along the east-west centre lines of Destor and Duparquet where they form a band $\frac{1}{2}$ to 1 mile wide that extends from within ½ mile of Duparquet lake to the Makamik road. East of the road the sediments occupy two isolated areas which lie north of the centre line of Destor township and which are exceptionally well exposed because of a recent fire that swept across eastern Destor. The series consists of conglomerate, slate, and arkose.

In addition to the strata just mentioned there are various occurrences of coarse conglomerate which appear to be older than the bulk of the Timiskaming strata and which are, so far as known, everywhere intimately associated with the supposedly pre-Timiskaming feldspar porphyry and quartz porphyry. The area of these conglomerates has not been separately distinguished from those occupied by the main body of Timiskaming strata.

Red Feldspar Porphyry Conglomerate. The red feldspar porphyry body lying east of Duparquet lake, at one locality at its eastern termination, grades imperceptibly along its southern edge into a conglomerate composed largely of boulders of the same porphyry. These boulders vary in shape from angular to well-rounded, and reach a maximum diameter of 9 feet. The interstitial material is composed of small, more or less rounded pebbles of fine-grained porphyry, greenish rhyolite, and some pebbles of an indeterminate composition, probably andesite, and the whole conglomerate is very tightly cemented together. Many of the smaller interstitial pebbles are sheared and in this respect the rhyolite or greenish pebbles have suffered the most and in many instances are drawn out so that they are hardly recognizable. The strike of the schistosity varies from north 62 degrees east to north 84 degrees west.

The different kinds of boulders and pebbles above one inch in diameter, in a number of separate outcrops, were counted. By multiplying the number of fragments of each variety by the square of the average diameter of the type, a numerical figure is obtained by means of which the relative proportions of each rock constituent of the conglomerate is indicated. The following table gives the results of two of these determinations, in the first the outcrop measured 5 by 2·5 feet, in the second 8 by 2 feet.

Type of rock	Number of boulders	Average diameter	Proportion of area
		Inches	
Red feldspar porphyry	34	2·5	212·5
Fine-grained red feldspar porphyry	6	1·0	6·0
Rhyolite	5	1·0	5·0
Red feldspar porphyry	50	6·0	1,800·0
Fine-grained red feldspar porphyry	11	1·5	24·75
Andesite	15	2·0	60
Rhyolite	7	1·0	7

The positions of all the observed outcrops of this conglomerate relative to the nearby outcrops of the red feldspar porphyry and the other Timiskaming strata are shown on the accompanying Figure 3. The contact of the feldspar porphyry conglomerate and the narrow band of slate to the south strikes approximately east and west and dips 70 degrees south. The width of the feldspar-porphyry conglomerate varies considerably within short distances. This variation is probably the result of original irregular deposition, but may be in part due to the close folding of the rocks such as is required to explain the relations in the eastern part of the area represented by the figure. Possibly the structure has been further complicated by faulting.

Quartz Porphyry Conglomerate. Associated with some of the bodies of quartz porphyry outcropping within and near the body of Timiskaming sediments is a conglomerate formed largely from disintegration products of the porphyry and similar in this respect to the red feldspar porphyry conglomerate described previously.

This quartz porphyry conglomerate is composed of angular to well-rounded boulders of various sizes up to 3 feet in diameter. Over a number of different areas, each about 30 square feet, on an outcrop near the Makamik road, a count of the different varieties of rocks making up the conglomerate was made and an average of the results is given below. The square of the average diameter multiplied by the number of boulders of a particular type of rock gives a numerical figure which indicates the relative proportions of each constituent.

Type of rock	Number of boulders	Average diameter	Proportion of area
		Inches	
Quartz porphyry	63	5	1,575·0
Andesite	34	2·5	212·5
Rhyolite	6	1	6·0
Pea-green rock	8	1	8·0

The pale green rock is dense and the pebbles of it on weathered surfaces are very conspicuous owing to their pea-green colour. They are possibly rhyolite. The larger boulders of quartz porphyry tend to be more angular than those formed from either andesite or rhyolite. The size and degree of angularity of the boulders decreased from north to south across the outcrop 300 feet wide on the Makamik road. The matrix amounts to approximately 1 per cent of the volume of the rock and consists of a heterogeneous mixture of more or less angular grains of quartz and feldspar and particles of rhyolite, andesite, and dense, fine-grained material, possibly fragments of fine-grained volcanic rocks. A large number of nodules of pyrite are present. These are commonly ¾ inch in diameter and break out readily from the rock, as many are surrounded by a thin layer of calcite. The pyrite nodules are restricted to the matrix. The oxidation of these nodules where they are particularly abundant has produced a gossan a few inches thick.

Besides the exposure on the Makamik road ½ mile south of the east-west centre line of Destor township, this conglomerate was also found ½ mile west of the Destor-Duparquet boundary at the southern edge of the band of Timiskaming sediments, and occupying a position with respect to

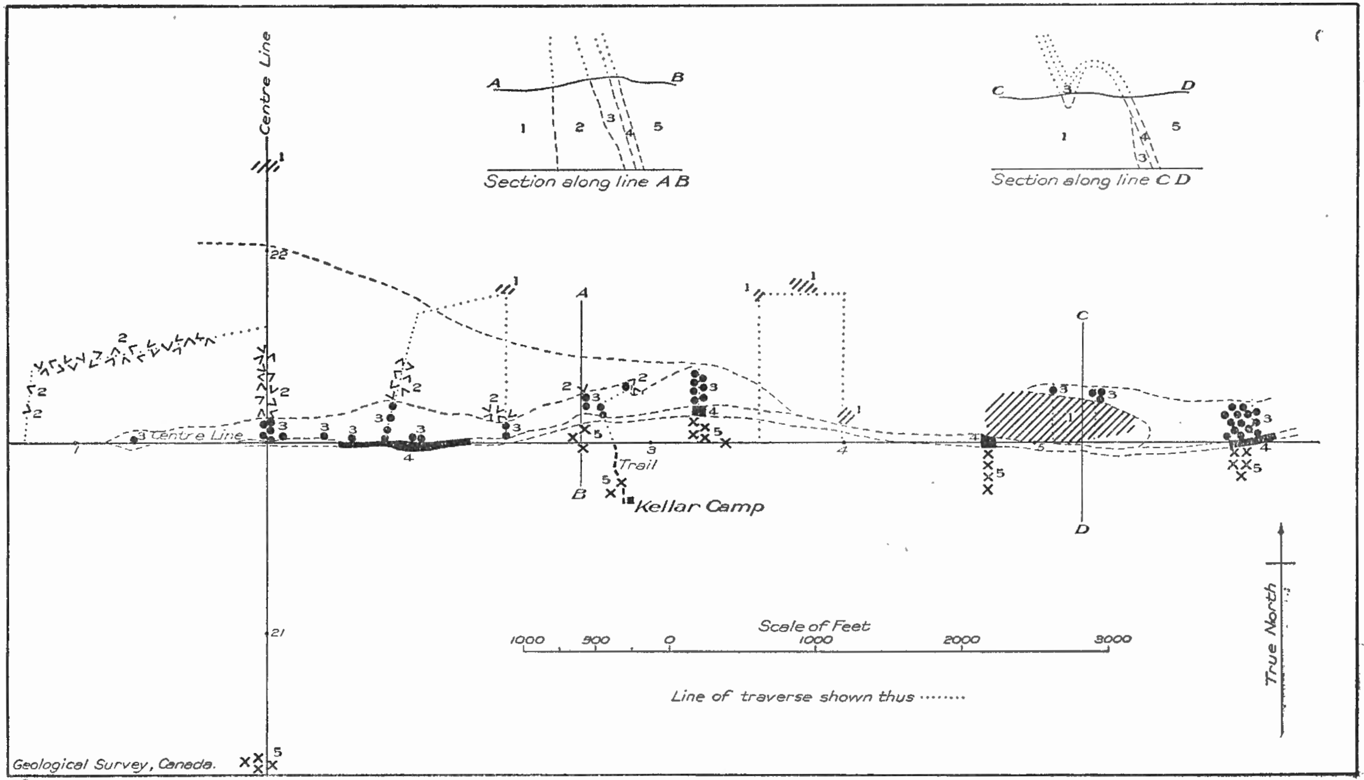

Figure 3. Positions of oberved rock outcrops near Kellar camp, Duparquet township, Quebec, illustrating mode of occurrence of porphyry conglomerate. Keewatin volcanics indicated by diagonal lines (1); red feldspar porphyry by angles (2); porphyry conglomerate by black dots (3); Timiskaming slate by solid black (4); Timiskaming conglomerate and arkose by crosses (5); positions of assumed geological boundaries by fine pecked-lines.

the later sediments similar to that of the red feldspar porphyry conglomerate on the north. The conglomerate of the exposure grades southward into normal quartz porphyry without any visible sharply-defined boundary between the two rocks. On the edge of the exposure a shallow gully 20 feet wide separates the quartz porphyry conglomerate from a band of slate 100 feet thick. This slate to the north is overlain by normal Timiskaming conglomerate which exhibits no schistosity. The boundary between the slate and normal conglomerate strikes north 80 degrees east and dips 60 degrees north.

The intimate association of these bodies of "porphyry" conglomerate with the masses of porphyry and the large sizes of many of the constituent boulders suggest that the conglomerates are somewhat abnormal as regards their mode of origin. Though the few known occurrences seem intimately associated with the Timiskaming sediments, it may be that the "porphyry" conglomerates are considerably older. If the bodies of porphyry have been preserved because they developed in or near the surface of the ordinary Keewatin volcanics, it may have been that the "porphyry" conglomerates were once as widespread as the porphyry and that they developed in situ; later on before the main phase of Timiskaming sedimentation developed, the blanket of "porphyry" conglomerate may have been largely destroyed by erosion, so that only the remnants were buried beneath, and preserved by, the main Timiskaming sediments.

Slate. The slate is dark brown, grey, or black, fine grained, usually very fissile, and forms a band which varies in width from 15 to 100 feet. It was traced almost continuously for 1¼ miles along the northern contact of the series near the centre of Duparquet township. It also outcrops on the Destor-Duparquet boundary and again on the Makamik road. This latter occurrence is unusual in that here the slate shows distinct banding. The bands consist of very fine, dark green argillite ½ to 1½ inches thick, alternating with coarser, even-grained, dark grey argillite ½ to 1¾ inches thick. The bedding strikes north 25 degrees west and dips vertical. Slaty cleavage striking north 55 degrees west has been developed in the finer-grained bands; the coarser-grained layers have remained massive though they possess a tendency to break at right angles to the bedding. On the Berner-Bachmann claims at the southern contact of the sediments slate outcrops ½ mile west of the Destor-Duparquet boundary.

Arkose and Conglomerate. The great bulk of the series consists of coarse arkose, grading in places into quartzite, and a distinctive and easily recognized conglomerate usually interbedded with the arkose to such an extent that the two rocks could not be separately mapped.

The arkose has an unusually even grain of $\frac{1}{40}$ inch diameter, or less. Its high quartzitic content is apparent on a fresh surface from the large number of minute, glassy grains of quartz that can be readily recognized. Oxidation has penetrated in most cases at least ⅜ inch deep; the light brown colour produced is in strong contrast with the light grey or olive-green of the fresh surface.

Under the microscope the arkose shows angular fragments of quartz and a few, relatively fresh, feldspar grains all of very uniform size but never tightly packed together. The fragments of quartz and feldspar are enclosed in a much altered matrix consisting of an intimate mixture of minute grains and flakes of kaolin, sericite, and calcite, and shreds of chlorite, all forming a dusty aggregate. The quartz fragments did not show strain shadows in the thin section examined.

The conglomerate forms about three-fourths of the sedimentary series and is everywhere characterized by the uniformity of its constituents as regards both shape and aggregate composition. The boulders and pebbles are invariably well rounded and very commonly, in outline, they are symmetrical, flattened ellipsoids with the long axis, the shorter axis, and the thickness in the ratio 10:8:3. The matrix of the conglomerate is identical with the arkose described above.

A wide range of rock types may be represented in a small outcrop, but it is very likely that other outcrops at widely separated points will contain practically the same number and kinds of rocks. The following table represents the results of a series of examinations made in order to give an approximate proportion of the different kinds of rock types in the conglomerate. The square of the average diameter multiplied by the number of pebbles gives a numerical figure which indicates this relative proportion.

Type of rock	Number of pebbles	Average diameter	Proportion of area
		Inches	
Andesite	51	2	204
Fine-grained volcanics	46	1·5	103·5
Syenite	9	3	81·0
Granite	7	3	63·0
Diorite	9	1·5	20·25
Feldspar porphyry	6	1	6·0
Quartz	3	1	3·0
Jaspilite (red)	2	0·5	0·5

The largest boulder found in the conglomerate is of syenite and measures 18 inches in length. The average size of the pebbles in the conglomerate does not exceed 4 inches in diameter.

The attitude of the strata varies considerably, but generally the strike is between north 90 degrees east and north 75 degrees west and the angle of dip within 5 degrees of vertical, though in one case a dip of 60 degrees was observed.

The matrix and a few of the softer pebbles of volcanic origin are locally sheared, but, with the exception of the most easterly exposure, the series as a whole shows remarkably little schistosity. In this easterly outcrop where the conglomerate pinches out it is highly schistose, and the greater number of the pebbles have been drawn out and mashed beyond recognition. An unusual feature is the absence of red jaspilite pebbles and the presence of a few bright green, sheared pebbles which were not noted elsewhere in the areas.

The correlation of the slate, arkose, and conglomerate with the Timiskaming is based upon: (*a*) the close infolding of the sediments with the Keewatin; (*b*) the lithological similarity of these sediments to the Timiskaming sediments lying to the west in Ontario, in Harker, Beatty, and German townships, and at Porcupine; (*c*) the appearance of a slight unconformity between the Keewatin volcanics and the sediments.

Structural Relations. Wherever the attitude of the flows could be accurately determined, north of the Timiskaming sediments, the tops of the flows faced south and the flows themselves were in many places overturned as much as 15 degrees in that direction. Favourably exposed outcrops to the south of the sediments are few and consequently the determinations there are not as precise; nevertheless, wherever examined, all evidence obtained indicated that the flows here face north. The structure of the area is then synclinal with the major axis lying approximately along the east-west centre lines of Duparquet and Destor townships. It is very probable that this synclinal structure is continued eastward into Aiguebelle along the same axial direction, but to the west in Hébecourt the structural geology is relatively unknown, except that there the flows have the same general strike as elsewhere in the area.

That an unconformity exists between the Keewatin and the overlying sediments is shown by the " porphyry " conglomerates which were formed mainly from products of disintegration of porphyries which are considered to be younger than the bulk, if not all, of the more usual Keewatin volcanics. The " porphyry " conglomerates lie at the base of the Timiskaming strata and thus show that a period of erosion and denudation occurred between the Keewatin and the deposition of the more normal type of Timiskaming sedimentation.

PRE-HURONIAN INTRUSIVES

Older Gabbro. Masses of coarse-grained gabbro occur around Duparquet and Hébecourt lakes and also north of these lakes. The gabbro is similar in all respects to that mapped and fully described by W. F. James[1] and H. C. Cooke[2] in the two map-areas to the south. An interesting feature, emphasized by this year's mapping, is the extension northward of these irregular bodies of gabbro more or less adjacent to a line drawn from the north end of Opasatika lake to the mouth of Abitibi river.

The gabbro was observed on the shores of the lakes to be intrusive into the older volcanics and Cooke found that the gabbro is cut by syenite porphyry. In the Abitibi-Night Hawk gold area[3] to the west the gabbro is cut by quartz feldspar porphyry and serpentine. In Destor map-area the Timiskaming sediments were nowhere found to be cut by gabbro, although in eastern Destor coarse-grained gabbro is exposed at two places between the Timiskaming strata and the Keewatin volcanics. The contact, if such exists, between the Timiskaming sediments and the gabbro is buried by drift and, therefore, it is impossible to determine definitely the age of the gabbro here. Mr. Cooke has considered it to be post-Timiskaming on the following evidence " . . . the older gabbro stands up in dykes having

[1] James, W. F.: Geol. Surv., Canada, Sum. Rept. 1922, pt. D, p. 87.
[2] Cooke, H. C.: Geol. Surv., Canada, Sum. Rept. 1922, pt. D, p. 52.
[3] Ont. Bureau of Mines, vol. XXVIII, pt. 2, p. 31.

steep or vertical contacts wherever observed, which is strongly suggestive of intrusion after the folding of the area was completed, in which case the older gabbro would be post-Timiskaming. Tentatively it has been placed as the oldest member of the group of intrusives that were intruded after the folding of the Timiskaming series."[1]

Peridotite. A dark green or black, coarse-grained, massive rock intrudes the Keewatin volcanics 1¼ miles east of the centre of Destor township and a smaller body of somewhat similar rock, intrusive into both the volcanics and pre-Timiskaming intrusives, is exposed on the Makamik road near reference plate 42. The larger mass extends for ½ mile east and west along the centre line and is about ⅛ mile wide. The rock weathers white and on a weathered surface many small, silvery white threads and veinlets of asbestos, up to ⅛ inch in width, are visible ramifying throughout.

A microscopic examination shows that the rock consists, almost entirely, of serpentine secondary after olivine. The serpentine presents a typical mesh-structure and the numerous rediating cracks traversing it are filled with secondary magnetite. Only one of the two thin sections examined contained a little augite which occurred interstitially around a number of former crystals of olivine. The augite is remarkably fresh and unaltered, though the cracks in it are filled with secondary magnetite. This iron ore has come very probably from the alteration of the olivine rather than from decomposition of the pyroxene. The peridotite in its former unaltered condition resembled most closely a wehrlite in composition.

In northeastern Ontario, from a number of localities more or less in the same latitude, many bodies of serpentine have been reported and their description is identical with that of the serpentine from Destor. As the peridotite has been generally considered to be older than the granite in these areas, and as there is no information in the Destor map-area regarding its place in the sequence of igneous activity, it has been assumed as older than the granite of northern Destor and Duparquet and younger than the older gabbro which it cuts in Ontario.

Granite. The southern edge of a large batholith of granite, extending one mile southward into the area, lies along the northern boundary of the townships of Destor and Duparquet for a distance of 10 miles. The granite is massive, medium to coarse in grain, and, megascopically, white feldspar and abundant quartz can be identified.

Microscopic examination shows that all the quartz grains contain innumerable small gas cavities. The feldspar consists of orthoclase and plagioclase, the composition of the latter as determined by its angle of extinction is approximately $Ab_{85} An_{15}$. Alteration of the orthoclase has been particularly intense and it is now almost wholly composed of an aggregate of dusty kaolin and flakes of sericite. The plagioclase also contains a multitude of minute flakes of white mica. Chlorite and penninite have been developed after the former primary ferromagnesian constituents which, from the outline and form of the alteration products, were probably

1 Geol. Surv., Canada, Sum. Rept. 1922, pt. D, pp. 53.

biotite. Some large grains of epidote are associated with the chlorite and a few are scattered separately throughout the feldspars. A Rosiwal analysis gave the following approximate composition for the unaltered rock: quartz 46·5; orthoclase 33·6; plagioclase 18·5; biotite 1·4.

In adjacent areas to the west, and especially around lake Abitibi, large exposures of granite occur and these intrusions are considered to be contemporaneous with, or slightly later than, the pre-Huronian folding and mountain building. Since the granite in Destor map-area is probably part of the same batholithic intrusion it has been placed in the time scale near the close of the pre-Huronan period.

Extending from lake Lois to within 3 miles of Abitibi river there is a zone of highly schistose rocks forming a contact aureole around the southern edge of the granite. This zone is separated from the massive Keewatin volcanics by a drift-covered area and wherever either type of rock is exposed it has its own distinctive characteristics and no gradation between the two was found.

The contact zone is typified by its extreme schistosity, its peculiar whitish weathered surface, and the numerous white quartz stringers and veins that have been introduced subsequent to the shearing. In places the rock resembles a closely sheared quartz porphyry similar to the pre-Timiskaming quartz porphyry described above. Elsewhere the zone, apart from the quartz veins, is composed of highly metamorphosed Keewatin rocks; tuffs, breccias, and flows.

Some of the quartz veins are reported to contain masses of pyrite, chalcopyrite, and galena, but little such mineralization was observed.

Quartz and Feldspar Porphyries and Pegmatite. Fine-grained quartz porphyry intersects the granite near its southern margin. The porphyry is composed of small, glassy phenocrysts of quartz about 1 mm. in diameter, scattered in a dense, aphanitic, light grey groundmass. A similar porphyry intrudes the Keewatin volcanics as large, irregular masses about 5 miles south of lake Lois.

The porphyry where it cuts the granite is in places cut by dykes of grey feldspar porphyry which shows many white phenocrysts of feldspar, square or tabular in outline, lying in a fine-grained matrix. Microscopic examination shows that the groundmass consists of small feldspar laths and that the rock as a whole is very highly altered to kaolin, sericite, chlorite, and carbonate.

Irregular masses of milky white quartz are found in many places in the granite, and a stringer east of the Makamik road on the northern boundary of Destor township carried a few large plates of molybdenite up to ½ inch in diameter.

Lamprophyre. A few lamprophyric dykes occur in eastern Destor and in Aiguebelle. Megascopically, they are medium-grained, dark grey in colour, and are characterized by innumerable shining phenocrysts. Microscopic examination of one of these dykes, which cuts the fine-grained quartz porphyry, shows that these phenocrysts are idiomorphic crystals of augite, predominately lath-like in outline. The small amount of interstitial material is composed of very basic feldspar which has a high index of refraction and a low double refraction. Biotite, now wholly altered to chlorite and penninite, had been present in minor amounts. The other alteration products are epidote and carbonate. A few grains of fresh apatite are scattered widely throughout the rock.

These basic dykes may be classed as augite camptonites, and, since they cut the fine-grained quartz porphyry, they represent an end product of the pre-Huronian igneous activity in the area.

ECONOMIC GEOLOGY

Prospecting in the area has been largely confined to the contact zone south of the granite, and adjacent to the band of Timiskaming sediments in the townships of Destor and Duparquet. Elsewhere in the area the volcanics are massive and it is improbable that these areas of relatively unaltered rocks would repay prospecting. The writer did not make a detailed examination of the various properties and the following is simply a record of the more important claims, and their general geological relationships.

BEATTY CLAIMS

John Beatty has been actively interested in the area since 1910 and at present holds a number of claims adjacent to Duparquet lake. Of these, island 25 in Duparquet lake and a group of claims east of the lake along the east-west centre line of Duparquet township are briefly described below.

(1) The southern half of island 25 is composed of coarse-grained gabbro which is intruded by a number of very fine-grained basic dykes. Near the southwest corner of the island one of these dykes 3 feet wide has been offset along a number of faults with a maximum throw of 10 feet. In a distance of 125 feet seven faults whose strikes vary from north 75 degrees west to north 20 degrees west, cut this dyke. Basic volcanic rocks now highly schistose form the northern part of the island and it is in these sheared and altered Keewatin volcanics that the values are found. The main sheared zone is mineralized with quartz, pyrite, and chalcopyrite, and in addition the basic volcanic rocks have been highly carbonatized. Free gold can be panned from the soft, surface-weathered products. Test pits and cross-trenching have exposed the sheared zone at different points on the island. The sheared zone strikes north 15 degrees west and has a steep southerly dip.

(2) The claims lying north of the east-west centre line in Duparquet township are about $\frac{3}{4}$ mile east of Duparquet lake. They are situated upon the western end of a large mass of red feldspar porphyry. This porphyry is pre-Timiskaming in age and it was probably intruded into the Keewatin formation, though its intrusive nature can only be inferred from its large size. The contact with the volcanic rocks to the north is buried beneath a valley which extends along the northern edge of the porphyry and on the south the porphyry, where observed, is in contact with the Timiskaming sediments. The porphyry contains a large number of phenocrysts of feldspar up to 1 inch in diameter scattered more or less irregularly in a

matrix which, under the microscope, is found to be composed of a felted aggregate of small plagioclase and orthoclase laths which have indistinct outlines and are generally much altered. All the phenocrysts are clouded with kaolin and flakes of sericite and by oil immersion of the least altered crystals their composition was found to be approximately that of anorthoclase.

The porphyry has been extensively sheared and shattered, presumably by the pre-Huronian folding movements. Later silification and mineralization have occurred along two main shear zones, each about 30 feet in width. The direction of schistosity in the most northerly shear zone is north 55 degrees east and in the other it varies from north 75 degrees east to north 80 degrees west. The mineralization consists of very minute grains and crystals of pyrite disseminated throughout the mass of the silicified rock. Near the eastern side of the claims there is a vein of white quartz, 30 inches wide, which also carries finely disseminated sulphides.

These claims were under option in 1924 to the Victoria Syndicate which did about 5,000 feet of trenching and sank a number of test pits.

BERNER-BACHMANN CLAIMS

This group of claims is situated in Duparquet township adjacent to the eastern boundary, in ranges IV and V about ¾ mile north of Destor lake. A camp was built in 1924 and a staff of ten men were employed for twelve months doing exploratory work on the property. A series of cut lines were run at intervals of 200 yards and were used as base-lines from which the claims could be systematically prospected. Coarse glacial drift covers a large part of the bedrock and the rock outcrops are mostly small and isolated. The major part of the work on the claims has been confined to a band, ½ mile wide and ¼ mile long, extending west from reference plate 16 on the eastern boundary of Duparquet township. A total of 8,500 feet of trenching has been done at different places across this band.

The oldest rocks consist of highly metamorphosed Keewatin basalts which are usually very schistose. Ellipsoidal structure is not common and the pillows are small. A structural determination on the attitude of the flows indicated that the upper side faces towards the north. Quartz porphyry of pre-Timiskaming age is abundantly exposed on the claims and at one contact with the basalt the quartz porphyry showed a chilled margin ¼ inch wide. The porphyry is typically light olive-green in colour and a large number of conspicuous glassy phenocrysts of quartz up to ½ inch in diameter are scattered in an aphanitic groundmass. In a number of places the porphyry is schistose, but this condition is unusual as it is characteristically massive. The grey feldspar porphyry exposed in several outcrops is considered a differentiation phase of the more widespread quartz porphyry, because, in addition to the large number of white feldspar crystals, it contains in many places numerous, large, glassy phenocrysts of quartz, and with the increase in percentage of these quartz crystals it grades into the normal quartz porphyry. In addition to the quartz porphyry the volcanics are intruded by red feldspar porphyry in the form of small dykes and irregular masses. This resembles somewhat the red feldspar porphyry exposed north of the band of Timiskaming strata and may also be pre-Timiskaming in age. It has not been found either in contact with the quartz porphyry or the Timiskaming sediments on these claims.

The quartz porphyry described above is intruded by dark green peridotite similar to that exposed on the Makamik road. The peridotite is now wholly altered to serpentine and carbonate and in addition has been shattered, and the small, irregular cracks so produced are filled with serpentine. Near the western part of the claims the quartz porphyry is cut by a light reddish-grey rock which contains a large number of small flakes of mica and a few phenocrysts of pinkish feldspar. Under the microscope the rock[1] is found to be very highly altered; chlorite has replaced the mica, and the feldspar crystals and the matrix have been largely altered to sericite and carbonate.

A part of the band of Timiskaming sediments extends across the northern part of the claims and the strata include a small area of basal "quartz porphyry" conglomerate overlain by slate, arkose, and conglomerate. Several bodies of quartz porphyry are exposed on these claims, within the area of Timiskaming sediments, but these bodies are considered to be older than the sediments. The porphyry outcrops are elongated parallel to the axis of the synclinal structure of the Timiskaming strata, and it is thought that the positions of the porphyry exposures indicate that the igneous rock and the overlying sediments have been closely folded and that erosion has laid bare the porphyry along the axes of the minor anticlinal folds.

The mineralization on the claims occurs in a number of shear zones, presumably by faulting, and disseminated throughout the red feldspar porphyry. Work on the claims in 1925 was being largely concentrated in three localities; one adjacent to the Destor-Duparquet boundary about $\frac{1}{8}$ mile south of reference plate 16, a second 3,000 feet west of reference plate 16, and a third about 2,000 feet farther west.

In the first-mentioned zone of operations the geological conditions are very irregular and poorly defined. The zone consists mainly of sheared and carbonated Keewatin lavas intruded by small masses of red feldspar porphyry. The porphyry is mineralized with minute crystals of pyrite disseminated evenly throughout the rock and the presumption, therefore, is that this porphyry has caused the mineralization of the lavas, because the quartz porphyry exposed elsewhere on the claims does not carry any sulphides.

The mineralization of the lavas took place in two distinct stages; the first comprised the deposition of fine to medium-grained pyrite as coatings on the slippage planes. This sulphide mineralization was followed by a shattering of the rock and the formation of cracks up to $\frac{3}{16}$ inch in width in which quartz, carbonate, and firmly crystalline specular hematite were deposited.

The second locality, 2,000 feet north of the camp, is somewhat simpler in detail. It consists principally of a shear zone, 100 feet wide, in Keewatin basalts which have been very intensely carbonated and in places

[1] The rock is a minette, possibly a differentiate of the red feldspar porphyry.

coloured bright green by small flakes of chrome mica; small stringers of milky white quartz are also abundant in the carbonated zone. The shear zone is intruded by small dykes of red feldspar porphyry and a large mass of the same porphyry lies to the south and is separated from the shear zone by 200 feet of glacial drift. Sulphide mineralization of the carbonated lavas is not extensive, though in places there are disseminated crystals of pyrite.

The third area of operations lies one mile west of reference plate 16 on the Destor-Duparquet boundary. Here, trenching has exposed Keewatin volcanics intruded by quartz and red feldspar porphyries (not in contact with each other) and a body of minette which cuts the quartz porphyry. There is a carbonated zone in which chrome mica and white quartz are abundant. A little sulphide mineralization has taken place in both the carbonated zone and in the relatively unaltered dark green volcanic rocks. The red feldspar porphyry as elsewhere on the claims contains finely disseminated pyrite.

No values were reported to occur in the sediments which lie in the northern part of the claims.

BROOKBANK CLAIMS

Adjoining the Berner-Bachmann property on the east, in Destor township, are a group of claims upon which considerable work has been done since 1923. During the spring of 1925 the claims were diamond drilled and large tonnages of low-grade gold ore are reported to have been blocked out.

The geological relationships here are similar to those occurring on the Berner-Bachmann claims. The rocks consist of sheared and carbonated Keewatin volcanics intruded by quartz and red feldspar porphyries. Timiskaming sediments are exposed near the northern boundary of the claims, but these sediments are not mineralized.

KELLAR CLAIMS

This group of claims lies at the centre of Duparquet township 1½ miles north of Duparos lake. A camp was built in the autumn of 1924 and some stripping done north of reference plate 3 on the east-west centre line.

The large mass of red feldspar porphyry exposed east of Duparquet lake pinches out on these claims and is cut by a network of narrow, reticulating veinlets of milky white quartz. The porphyry in the vicinity of these stringers of quartz has been highly altered by metasomatic action and impregnated with a few small crystals of arsenopyrite. The quartz has been in part replaced by finely crystalline galena and tetrahedrite, intimately intergrown. Small, irregular grains of chalcopyrite and stains of malachite and azurite are occasionally found. The mineralized stringers are said to contain high gold values.

CALUMET ISLAND, PONTIAC COUNTY, QUEBEC

By R. W. Goranson

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Illustrations

INTRODUCTION

Calumet island is situated in Ottawa river about 58 miles northwest of Ottawa. Campbells Bay, a village on the north shore of the river on the Waltham branch of the Canadian Pacific railway, is the railway station nearest to the island. From there a 4-mile wagon road runs south to the village of Bryson where a bridge connects the mainland with the island. A ferry plies between Campbells Bay and Calumet village, and another between Fort Coulonge and the northeastern end of the island.

The eastern channel of the river, called the Calumet channel, is navigable to Bryson. Above Bryson this channel is broken up by numerous falls, and, during the summer of 1924, an hydro electric plant was under construction at Grand Calumet falls. The western channel is very rough, and is well named the Rocher Fendu river, for the whole channel is a succession of falls and rapids.

The island supports a farming population of about 1,200, chiefly of French and Irish descent. Because of the distance from markets, grain is the chief product raised. The east-central part of the island is the most productive.

A lead-zinc deposit occurs on the southwestern part of the island and, chiefly for the purpose of examining this mineral occurrence, the writer spent the field season of 1924 investigating the geology of the island. The earliest geological reference to Calumet island was made by Sir William Logan who, in 1845, made a reconnaissance along Ottawa river between Ottawa (then Bytown) and lake Timiskaming, and later published his data in the Report of Progress for 1845-46, Geological Survey, Canada (1847). Short paragraphs on the zinc production of Calumet island are contained in the reports of the Division of Mineral Statistics and Mines, in the annual reports of the Geological Survey between 1892 and 1902. In 1908 there were published a report and map[1] by R. W. Ells, dealing

[1] "Report on the Geology and Natural Resources of the Area Included in the Northwest Quarter-Sheet, No. 122, of the Ontario and Quebec Series, Comprising Portions of the Counties of Pontiac, Carleton, and Renfrew"; Geol. Surv., Canada (1908).

with the geology of a large region of which Calumet island is a part. In 1916 a description of the lead and zinc deposit of Calumet island was given by W. L. Uglow.[1]

PHYSICAL FEATURES

The major axis of the island runs north for 5 miles, then swings northwest for 6 miles, making a total length of 11 miles. The average width is about 4½ miles.

The southern end, except for a square mile of sandy plain in the southwestern part, is a rocky ridge called "The Mountain" by the local inhabitants. This ridge rises 250 to 300 feet above the river and extends north for 5 miles to about the centre of the island where it slopes under a mantle of soil. This soil-covered area is good farming land for a distance of 2 or 3 miles north. Farther north a deposit of sand lies at the surface and forms a sand-plain which occupies about 8 square miles of the northern part of the island and supports a young growth of jack-pine.

The eastern side of the central ridge, in the southern part of the island, slopes smoothly down to Calumet channel, but 4 miles north the foot of the ridge swings into the island, leaving flat farming land about a mile wide between the ridge and the river. The western edge of the ridge is a steep scarp which for a distance of 5 miles north of the southern end of the island follows the shore of Rocher Fendu channel. Beyond this, at the widest part of the island, the scarp jogs east for a mile and then runs a little west of north. The area between the scarp and Rocher Fendu channel in this northern part of the island is low ground covered by a dense growth of bush and trees, and cut up by rock ridges and knobs between which lie swamps, bogs, marshes, and lakes.

The maximum difference in elevation exhibited on the island is about 300 feet. The lowest point lies in the southwestern part of the island and has an elevation of about 260 feet above mean sea-level. The average height along the axis of the main ridge is about 550 feet.

GENERAL GEOLOGY

GENERAL STATEMENT

Calumet island is mainly underlain by Precambrian rocks consisting of three main types: limestone, amphibolites derived from gabbro and diorite, and granite. In the northwestern part of the island is a small area floored with horizontal Ordovician sediments: sandstone, shale, and dolomite.

The oldest rocks are Precambrian limestones which with narrow, intercalated beds of impure limestone, outcrop here and there in isolated patches. These sediments are cut by sills, dykes, and other bodies of diorite, hypersthene diorite, hypersthene gabbro, and quartz gabbro which

[1] "Lead and Zinc Deposits in Ontario and in Eastern Canada"; Ont. Bureu of Mines, vol. XXV, pt. 2, pp. 5-7.

outcrop over more than half of the southern part of the island. In most places the gabbro-limestone contacts are sharp, but in some places the limestone and gabbro have formed a hybrid rock consisting chiefly of hornblende, scapolite, apatite, feldspar, and a little carbonate. These rocks have been folded and faulted, and the folding is very intricate in places. The major structure, however, has a prevailingly northeast strike with a southeast dip. Regional metamorphism has recrystallized the limestone to a coarse-grained marble, the gabbro and diorite to amphibolites.

A pegmatitic, potash-granite magma has intruded this folded and contorted series of rocks. It crystallized to a coarse-grained, porphyritic, alkaline granite which now occupies about a third of the northern part of the island. During stages of the crystallization of the granite, solutions penetrated the country rock where they reacted on the limestone to form a complex suite of contact minerals. In the amphibolites there was formed in places an intricate network of dykelets and lit-par-lit injection gneiss, and the mineral grains of the amphibolite were in part replaced by microcline and quartz. Granite pegmatite dykes cut the granite and intruded rocks; quartz-tourmaline veins and sulphide deposits were formed; and, last of all, was the formation of lamprophyre dykes.

Subsequently the region was subjected to erosion and by Ordovician time was reduced to a physiographic state very similar to the one in which it is now found. In the early Ordovician sea, Chazy grit, sandstone, dolomite, and shale, were laid down. These sediments, later subjected to extensive erosion, are now represented by one small patch in the northern part of the island.

The events of Pleistocene glaciation are indicated by glacial deposits which in places form small eskers. Glacial striæ trend about south 30 degrees east. During the Champlain epoch the area was submerged and thinly laminated beds of sand, silt, and clay were laid down.

Table of Formations

Quaternary........	Champlain.....................	Clay, silt, sand
	Glacial epoch..................	Gravel, sand, boulder clay
Palæozoic..........	Chazy (?)......................	Finely laminated, gritty shale; hard, grey dolomite; grit, sandstone
Precambrian.......		Lamprophyre dykes Pegmatite dykes Granite
	Buckingham series.............	Diorite, gabbro, norite; now amphibolites chiefly
	Grenville series................	Grey limestone, impure calcareous beds

GRENVILLE SERIES

The oldest group of rocks found on Calumet island belong to the Grenville series and consist of light bluish-grey and white limestone, a little white dolomite, and some calcareous argillaceous material which now occurs as fine-grained siliceous rocks interbedded with the limestone.

The limestone is coarsely crystalline, and in many localities is fairly pure calcite, as in the case of the outcrops which extend from Rocher Fendu channel at Mice rapids to lots 11 to 16, range VI; other such outcrops are found on range IX, four lots south of Berry river, and at the south end of the island. Dolomite is locally abundant, as along Rocher Fendu channel at Mice rapids where it is associated with diopside rock. Much of the limestone has been highly altered by the contact action of the igneous intrusions and now consists essentially of lime silicates.

Diopside is a common contact mineral and in places forms large bands of pure, white diopside rock which varies from a medium to a very fine-grained, almost aphanitic, rock. The finer-textured varieties, being more resistant to erosion, stand out as knobby ridges in the more coarsely-textured material. The largest belt stretches from Mice rapids, on Rocher Fendu channel, across the island to Calumet channel, and averages about a mile wide. The rock of this belt contains numerous bands of quartz which range in width from a fraction of an inch to a foot, and average 3 to 4 inches. Going northwest, across the strike, between ranges VII and VIII, the quartz bands become more abundant. On the eastern end of lot 11, range VII, the quartz bands make up one-half to two-thirds of the rock. The white diopside rock is succeeded to the north, on range VIII, by finely banded, fine-grained, impure limestone and siliceous beds about 100 feet wide and these again are succeeded by coarsely crystalline limestone.

Diopside rock also occurs in areas where limestone and granite are intermixed, as just north of Green island in Rocher Fendu channel where the rock is diopside with some carbonate. Tremolite is associated with diopside, but is apparently an alteration product of it. Diopside also occurs as the principal rock-forming mineral in the metamorphic limestone outcrop of range IV along the Rocher Fendu shore, especially associated with the granitized parts.

Tremolite, where it is an important constituent of the metamorphosed limestones, is accompanied by many contact minerals, including phlogopite, clinochlore, calcite, chondrodite, quartz, graphite, etc. These minerals occur in the contact aureoles about pegmatite dykes which have been injected into the limestone in great profusion. The tremolite is commonly an alteration product of diopside. This is well shown at the eastern end of lot 5, range V, where a quartz-diopside rock is in contact with amphibolite. The tremolite occurs as a sheath-like aggregate replacing diopside.

A narrow band of metamorphic limestone which crops out along the west shore of the island in range IV has been injected by pegmatite, and converted to a diopside rock containing large books of twinned muscovite. Solutions later reacted on the diopside rock to form an interlocking mesh of tremolite prisms, many of them carrying poikilitic inclusions of quartz and calcite. Quartz later replaced more of the rock and also the calcite remnants included in the tremolite. Carbonate still remains in the rock and where this has been leached out a honeycombed mass of tremolite crystals remains.

Chondrodite is a common mineral at the south end of the island. For example, at Mountain chute the rock consists of calcite, a little phlogopite, and a greenish chondrodite. The chondrodite has inclusions of calcite elongated parallel to the b-crystal axis of the chondrodite. At Grand Calumet falls a light green chondrodite is sprinkled abundantly through calcite.

The limestone occurring at the granite contact and as blocks included in the granite has in general undergone intense alteration. It contains abundant fluorapatite, titanite, diopside-hedenbergite, microcline, albite, hornblende, biotite, scapolite, some epidote, and some fluorite. Other minerals, including tremolite, diopside, quartz, etc., are also present and usually represent a replacement which is later than the time of formation of the first enumerated minerals.

BUCKINGHAM SERIES

The rocks of the intrusive Buckingham series are now represented by hornblende gneisses, or amphibolites, with some less metamorphosed gabbro and diorite. In many places regional and contact metamorphism has so altered the mineral composition and texture of the rocks that their original character can no longer be ascertained. Some are hybrid rocks resulting from limestone.

The typical amphibolites, for the most part, consist of hornblende, and feldspar ranging from albite-oligoclase to labradorite. Apatite, carbonate, garnet, quartz, biotite, magnetite, and ilmenite are accessory. Here and there remnants of diopside (diallage), hypersthene, and occasionally micropegmatite, can be found. The amphibolite is usually well banded, with alternate light bands rich in feldspar and dark bands rich in hornblende. In some places the rock is relatively coarse grained and variable in composition. The main rock type is of a gabbroid composition, but there are present subtypes represented by quartz diorite, hypersthene diorite, quartz gabbro, and hypersthene gabbro (norite). If olivine were ever present it has been completely converted to secondary minerals which give no clue to its former presence. Magnetite and ilmenite are rather rare for this type of rock. Small bodies of hematite, ilmenite, and magnetite, however, do occur locally as segregations.

GRANITE

Following a period of deformation of the Grenville series and the Buckingham series of intrusives, a potash-rich, granite magma intruded the complex, and crystallized as a coarse-grained, pink, pegmatitic granite which is variable in texture and composition. The chief minerals are pink to red microcline, albite-oligoclase, microperthite, and quartz which is segregated into lenses of coarsely crystalline, anhedral grains. In places minor accessories such as zircon, apatite, and biotite are found. Where the granite is in contact with limestone or includes limestone blocks, it contains green diopside, titanite, calcite that looks primary, sodic hornblende (approaching a glaucophane), and large apatite crystals. Secondary minerals are leucoxene, calcite, muscovite, and kaolin.

The amount of quartz and the proportions of the feldspars vary a great deal. The chief feldspar is microcline, but locally soda feldspar in separate crystals makes up half the feldspar. The amount of quartz is variable and in places forms half the rock, but the average mineralogic composition of the granite is about 30 per cent quartz and 70 per cent feldspar in which potash feldspar predominates.

The presence of inclusions affects the colour of the granite. Where these occur it is very streaky and splotchy. Where limestone inclusions are abundant the granite is white or a very pale pink. In the vicinity of amphibolite the granite is uniformly of a reddish colour.

The texture, though generally porphyritic, is also variable. In places the feldspar phenocrysts are 6 inches to even a foot or so in diameter. The groundmass itself is porphyritic, with smaller phenocrysts of feldspar, in a matrix made up chiefly of quartz and micropegmatite. In some places the rock is a graphic granite; in others it has an hypidiomorphic-granular habit.

The largest body of granite on the island outcrops as a series of ridges in the low, swampy area of the northwest part of the island, and also forms many islands in Rocher Fendu channel. This body occupies about 6 square miles, but in part carries masses of amphibolite and altered limestone.

Granite probably underlies the whole island, as indicated by the widely occurring pegmatite dykes, by lit-par-lit injection gneiss produced from greenstones, and by rather extensive impregnations and feldspathizations of the hornblende gneiss (amphibolite), the principal areas being on range IV, lots 16, 17, and 18, and on the southern part of range II. In many places the gneiss is criss-crossed by a network of narrow, pink, pegmatitic granite dykes which average less than one inch in width.

The granite is distinctly later than the folding and regional metamorphism of the intruded rocks and bears no causal relation whatever to the structure of the region. It is, on the whole, a crosscutting body. The structural orientation of large, apparently detached masses of amphibolite and limestone in the granite is conformal to the general structure of the area. On Green island there are a number of large blocks of limestone included in the granite. This limestone had been intruded by a sill of gabbro (now an amphibolite). The lines of strike of the detached parts of this sill in the different limestone blocks, when joined, form a straight line. In fact the relation of the structure of the large, included blocks as a whole, to the general regional structure, is so strikingly conformal that it is probable they are not inclusions but roof pendants.

DYKES, ETC.

Following the intrusion of the granite proper, aplite and pegmatite dykes, sills, and irregular bodies formed throughout the area, cutting the granite, amphibolite, and limestone. The pegmatite dykes range in width from the thickness of a thread to 50 or more feet. Most of them have a graphic granite texture, but in many the minerals are segregated in irregular lenses of anhedral grains, especially in the case of quartz.

The aplites, chiefly albitites, have a fine, sugary, even-grained texture, and consist chiefly of an interlocking aggregate of quartz and albite, with, in places, minor amounts of hornblende, biotite, and zircon.

The last episode of the igneous activity was the formation of lamprophyre dykes, which are found crosscutting the amphibolite and limestone beyond the immediate vicinity of the granite. Most of them are rather narrow, but one was noted which has a width of not less than 12 feet and which may be much wider. This dyke was a fine, even-grained, dark grey, much altered odinite. The wider dykes are porphyritic in the centre with phenocrysts of carlsbad twinned feldspar.

CONTACT METAMORPHIC EFFECTS

The contact metamorphic effects produced in the limestone and amphibolite of Calumet island are ascribed to reactions produced by mobile solutions which, during the late stages in the crystallization of the invading granite, were localized, and traversed both the intruded rocks and the crystallized granite. The mobility of these solutions is ascribed chiefly to the presence of volatile constituents, of which water possibly was the most important.

It is thought that these solutions while moving, perhaps discontinuously, through the fractures and pores of the rocks, would change in composition as a result of the addition of new components derived from the rock being traversed and the deposition of minerals representing changing equilibria caused by changing temperatures. Thus the solutions which replaced rock minerals and deposited, say, diopside-hedenbergite, orthoclase, etc., at one place, would at some other place farther removed from the source deposit a different suite of minerals. Along these channels the solutions would, moreover, change in composition with lowering temperatures, so that minerals deposited earlier would become unstable with respect to later phases of the solutions and be reacted on to form a suite of minerals which previously had been deposited farther from the source.

Contact Metamorphic Effects in Limestone

The contact metamorphism produced in the limestone can be divided into three zones on the basis of mineralogy and position relative to the granite-limestone contact. These zones are:

(I) A zone characterized by abundant feldspar. This zone is very narrow and occurs at the granite-limestone contact. The limestone inclusions and roof pendants, where fracturing has taken place, also show the same type of metamorphism.

(II) A zone characterized by dark-coloured silicates. This zone occurs outside of zone I, i.e., farther removed from the contact. Except where extensive shattering has occurred the zone is very narrow.

(III) A zone characterized by light-coloured silicates. This zone occurs outside of zone II and is of variable width, the width being in large part proportional to the amount of fracturing. It grades outward into the zone of recrystallized calcite (marble).

Zone I. The chief constituents of the first zone are microcline, albite-oligoclase, microperthite, and micro-pegmatite. They occur with zircon, large grains of fluorapatite, scapolite, calcite, quartz, and a suite of dark-coloured silicate minerals such as abundant titanite, diopside-hedenbergite, a deep bluish pleochroic hornblende, and biotite. Other minerals occasionally present are epidote and fluorite, but these seem definitely later than the above minerals. In the granite, vein-like areas can be found in which microcline phenocrysts are in stages of replacement by a relatively fine-grained aggregate of microcline, albite, quartz, and calcite. This type of replacement is thought to have proceeded with the metamorphism of the limestone, as is shown rather clearly in exposures on the small islands situated in the rapids along the southwest corner of Sullivan island. There, limestone is intimately mixed with granite and contains large crystals of hornblende up to a foot across, microcline, albite, and some sulphide grains. A thin section of the granite shows veinlets of microcline, albite, calcite, and quartz, replacing a large microperthite crystal. This phenomenon occurs where the inclusions and the granite have both been fractured. Where limestone blocks occur in which fractures are not common and do not extend into the granite, the interiors of these blocks are relatively unaltered and if the blocks are large they may consist almost wholly of recrystallized calcite.

Zone II. The second zone is characterized by a predominance of dark-coloured silicate minerals. These minerals include diopside-hedenbergite, titanite, a deep bluish pleochroic hornblende, and biotite. They are associated with abundant scapolite and quartz. Calcite is present as unreplaced remnants of marble and as a deposition by later solutions. In places the rock is essentially a scapolite-hedenbergite rock, in other places titanite predominates. Orthoclase is fairly common in some cases, for the boundary between zones I and II is not sharply defined.

Zone III. This zone is characterized by white or very light green diopside, tremolite, phlogopite, and chondrodite. Quartz, and, in places, clinochlore, are abundant. These minerals are usually found scattered through granular calcite, but some large areas are made up wholly of a white diopside and quartz.

Tremolite replaces diopside and occurs also as fine needles in leached vugs in the diopside rock. Serpentine, chlorite, and talc are found replacing tremolite and diopside.

The boundary between this zone and zone II is rather sharp, for, although light-coloured silicates are found in the zone of dark-coloured silicates (zone II), these dark-coloured minerals seem definitely limited to zone II. This boundary between the two zones is very irregular and its position is largely governed by the physical character of the limestone, such as fracturing. The transition to unaltered marble is not definitely marked, being a fading boundary, and, where fracturing is abundant, light-coloured silicate minerals have replaced calcite along the fracture walls of the marble.

On lots 5, 6, and 7, range IV, along the shores of Rocher Fendu river, pegmatite dykes occur which are 15 or more feet wide. Large feldspar crystals and quartz are present in the middle of these dykes; along their borders are large books of complexly twinned muscovite and white diopside with meshes of tremolite prisms replacing diopside. There is also a little scapolite present. A later generation of minerals with a higher water content replace these minerals; for example, feldspar is altered to muscovite, hornblende is present as a replacement of pyroxene, and the hornblende is itself replaced to some extent by phlogopite. These dykes are deficient in dark-coloured silicates compared with dykes closer to the granite outcrops and have practically no iron and titanium-bearing minerals. It is thought that the solutions may have deposited the dark-coloured silicate minerals before they had reached this locality.

Phosphorus, titanium, iron, and zirconium did not travel far from the granite. For example, at and near the granite contact, apatite is very abundant and in large crystals. On going out into zone II the crystals decrease in size and disappear on passing into zone III. Titanite is found in large pegmatite dykes remote from the granite contact, but where the solutions have had to traverse narrow fractures it is lacking. The iron is present in lime-iron silicates which are restricted to a narrow zone around the granite. These silicates are found jutting out into the limestone only where extensive fracturing has occurred.

The minerals of the zone of light-coloured silicates (zone III) contain chiefly lime, magnesia, alumina, silica, and fluorine. The alumina, fluorine, most of the silica, and much of the magnesia have certainly been transported. It is thought that these minerals of zone III result from components remaining after the solutions have reacted to form the inner silicate shell.

In many places the minerals of zone III have been superimposed on the suite of minerals in zone II and have partly replaced them. Similarly in the zone of light-coloured silicates tremolite is found replaced by serpentine and talc. Lowering temperatures may have been the important variable in this latter effect.

Contact Metamorphic Effects on Amphibolite

The contact metamorphic effects produced on amphibolite have resulted in the formation of lit-par-lit injection gneiss with silicification and feldspathization of large areas of the amphibolite or, as it is in many instances called, granitization. Solutions emanating from pegmatite dykes have also effected considerable changes in the neighbouring amphibolite.

Surrounding the granitized areas are broad zones of quartz-albite-biotite schist. The albite is an alteration of the more calcic plagioclase, the biotite an alteration of hornblende. Quartz replaces both hornblende and plagioclase. Sericitization of the plagioclase is also common. Zircon and titanite are absent.

In some places the quartz-albite-biotite schist occurs with no granitized amphibolite outcropping in its near vicinity. The inference is that the granitized part lies below the schist.

On approaching nearer to the granitized areas lit-par-lit injection gneisses are found. They are banded rocks, the banding caused by the variation in colour between the quartz and pink feldspar and the dark hornblende and biotite. The biotite is usually phlogopitic and the hornblende approaches a glaucophane in appearance. Hornblende and biotite remnants are present in the microcline and quartz bands and microcline and quartz occur in the hornblende-biotite-plagioclase bands as replacements of these latter minerals. In some places microperthite was found which had formed from the replacement of plagioclase by microcline and in other places a simulation of micropegmatite structure was observed and was due to a replacement of feldspar by quartz. Other minerals commonly present in these gneisses are apatite, calcite, and muscovite.

On passing still farther in towards the completely granitized rock the dark bands progressively diminish in number and extent, microcline and quartz replacing more and more of the dark minerals until finally a pink, banded granite consisting of microcline, microperthite, zircon, and titanite results as the end product.

The conclusion arrived at is that the solutions which formed these lit-par-lit gneisses and granitized areas were very mobile. If they had represented a magma which was squeezed in and then recrystallized the end result would have been a rock intermediate in composition between the amphibolite and the granite. This is not, however, what took place, for the iron, calcium, and magnesium originally present in the amphibolite decrease in amount with increase in intensity of the process, being absent in the completely granitized rock.

The process of replacement is a very delicate one and is believed to be caused by a gradual replacement of the amphibolite by moving solutions which emanated from the later stages of the crystallization of the granite.

The hypothesis offered is that the solutions moved up, the planes of schistosity of the amphibolite depositing quartz and microcline first in these open spaces. From these channels the solutions seeped into the amphibolite bands through minute fractures and pores, replacing hornblende, biotite, and plagioclase by quartz, microcline, and minor amounts of zircon and titanite. The formation of quartz, replacement of hornblende by biotite, and leaching of lime from plagioclase to form quartz-albite-biotite schist would represent a less intense reaction produced by the spent solutions travelling out from the granitized areas.

Narrow pegmatite dykes are very common in the amphibolite, either as injections along planes of schistosity or crosscutting these planes. Usually both types of dykes are present at the same locality. Those that crosscut are very irregular, winding in and out like highly twisted curves and forming in many places an intricate network, in some cases no wider than a thread. When they occur in such a network they are usually less than one inch wide.

The pegmatite solutions have reacted on the amphibolite walls to recrystallize the rock to coarse black hornblende borders. The dykes contain quartz, microcline, albite, and large crystals of hornblende. The quartz and feldspar are usually present as coarse graphic granite, but in many places feldspar cuts through the recrystallized hornblende in narrow veinlets. For example, at the eastern end of lots 24 and 25, range II, a coarse granite pegmatite about 8 feet wide occurs in amphibolite. Its minerals are segregated in coarse blebs. Hornblende, present as crystals with faces up to 1 by 2 feet in size, is strewn along the centre of the dyke in irregular bunches. Along the eastern edge of the dyke hornblende is abundant, but along the western contact it is very pockety. The mineralogy of the wall-rock includes abundant titanite, apatite, quartz, biotite, bluish pleochroic hornblende, oligoclase, orthoclase, some pyrite, chlorite, and calcite. Orthoclase replaces oligoclase in such a way that a replacement microperthite has resulted. Forty feet from the dyke the amphibolite contains no titanite, but has more hornblende, more biotite, and abundant apatite. Some orthoclase is present even at this distance from the pegmatite, chiefly as minute veinlets in plagioclase and hornblende.

In the northwestern part of lot 23, range I, a large granite pegmatite, containing quartz, microcline, and biotite, crosscuts a gabbro gneiss. The gneiss borders have been impregnated with microcline and biotite for a distance of about 4 inches.

PALÆOZOIC STRATA

The northern end of the island is underlain by Palæozoic rocks, mostly concealed beneath sand and swamps. The strata form the southern fringe of a large outlier which includes the whole of Allumette island a few miles north.

The basal bed is a coarse, gritty sandstone which upwards becomes shaly. It is overlain by a very fine-grained, bluish grey, slightly quartzitic, dolomite and this by a finely laminated quartzitic shale which has been ascribed to the Chazy.

PLEISTOCENE

Outcrops of glacial deposits are not common, for they are concealed for the most part beneath sand and silt deposited during the Champlain submergence. Except for an esker-like mass of gravel, boulders, and sand, roughly crossbedded, which occurs on lot 9, ranges VI and VII, the chief evidences of glaciation are found in the general topography.

A large sand-plain occupies the northeastern part of the island. It is very flat and is underlain by a fine-grained, light brown and grey sand. A similar sand-plain occurs in the southwestern corner of the island.

Along the northeastern banks of the island, at low water, silt and clay beds outcrop which contain abundant concretionary nodules. In some of these nodules skeletons of fish have been found. Farmers have also reported finding shells when sinking wells through these beds.

The northwestern part of the island is low and covered by lakes, and by marshes, swamps, and bogs which represent silted-up lakes. A rather steep scarp running along range VII separates it from the high, well-drained ground to the east. Just north of the Dunraven post office the scarp swings west to the river.

CALUMET LEAD AND ZINC MINE

This property is situated in the southern part of the island on lots 9, 10, and 11, range IV, Calumet island. It was staked by John Lawn and turned over to James and Calvin Russell who did some development work and in 1893 shipped a few tons of ore to Swansea, England. This sample is said to have contained 13 per cent lead, 38·9 per cent zinc, and 11 ounces of silver per ton.

The Grand Calumet Mining Company of Ottawa worked the mine in 1897 and 1898, and in 1898 shipped ore.

In 1911 the mine was taken over by the Calumet Metals Company. The same year a concentrating mill with a capacity of 150 tons was erected.

In 1913 the property was operated by the Calumet Zinc and Lead Company. A law suit instituted by some of the shareholders resulted in an order of the court that the property should be sold at public auction for the benefit of the plaintiff shareholders. The sale was made in 1917 and the property was bid in for the English bondholders.

The following statement of production was obtained from the files of the Mines Branch, Department of Mines.

Year
1893: 13½ tons shipped to Swansea, Wales
1894: No shipment
1895: Idle
1896: No information
1897: No information
1898: 1,100 tons shipped to Antwerp, Belgium, averaging 32 per cent zinc, 9 per cent lead
1912: No shipments; construction
1913–14: No information
1915: Idle
1916: No information
1918: 22 tons shipped to Omaha, Nebraska, from old stock; lead, 19,892 pounds; gold, 6·2 ounces; silver, 1,335 ounces

The ore occurs replacing amphibolite along a shear zone that has a general trend of north 20 degrees west. The planes of schistosity dip rather steeply to the east. Locally, the original minerals and texture of the amphibolite are preserved and the rock is known to be an altered hypersthene gabbro or diorite. It is now a dark green to almost black, fine to medium-grained, schistose rock.

In the amphibolite are patches containing lime silicate minerals which include tremolite, scapolite, and clinozoisite. Calcite, thought to be primary, is also rather abundant in some of these patches which probably represent remnants of limestone. The primary calcite is present as large, irregular, complexly-twinned grains which show distinct evidences of replacement by lime-silicate minerals such as scapolite, tremolite, and diopside. Vein calcite is not uncommon, but it is readily distinguishable from the primary calcite. The vein calcite cuts through the lime-silicate minerals and primary calcite as narrow veinlets.

Where the ore masses consist of heavy sulphide ore, what are thought to be remnants of primary calcite are usually present. For example, such calcite is found in the ore lenses across the face of the Bowie cut, in the Lawn workings, and in the ore from the Longstreet and St. Anne shafts. Where calcite remnants are absent, the ore is of a poorer grade. The shear zone seems to have offered a good channel for the ore solutions. A further localization of the ore may then have been due to the presence of limestone masses which, as compared with the amphibolite, were more easily replaced. If this conclusion is correct then any conservative estimate of ore tonnage present can only be made on developed ore-bodies, for the sizes and numbers of the limestone inclusions cannot be foretold.

The southern extermity of the ore-bearing zone is not known, but about midway along the boundary between lots 7 and 8 there is exposed a biotitized, silicified zone about 850 feet wide, and in this zone an open-cut 6 feet wide and about 24 feet long east and west, displays a small amount of chalcopyrite, sphalerite, pyrrhotite, and galena scattered through amphibolite in small, isolated lenses and patches. This same zone also crops out along the boundary between lots 8 and 9, but only small, scattered grains of sulphides were there observed.

Five shafts and numerous open-cuts have shown the zone to contain ore lenses on lots 9, 10, and 11 (*See* Figure 4). The shafts and cuts were full of water at the time of the writer's examination (1924), and, therefore, the following notes on underground development are based on reports made by others at various times.

The most southerly working is the Bowie shaft on lot 9. The opening consists of a series of trenches which increase in depth to the north, the deepest being 42 feet. From the lowest bench a vertical shaft was sunk 32 feet and a level driven at 52 feet from the original surface. The ore now exposed in the cut is chiefly sphalerite with abundant galena, pyrrhotite, and, in places, chalcopyrite. It forms lenses, some of which are nearly solid sulphide, up to 2 feet wide and about 6 feet apart across the face of the cut with smaller bunches of sulphide scattered irregularly between them. The face of the cut is 34 feet wide, and an average sample across the whole face would be low grade.

The Lawn shaft is 1,312 feet northwest of the Bowie. It has a depth of 57 feet 8 inches. A cut has been made 100 feet west of this shaft and a small incline sunk which dips toward the shaft. This incline is stated to be about 18 feet deep and has gone through considerable limestone judging from its dump. The ore here contains more lead than at the Bowie, and is reported to have a fair amount of silver. Farther west is a shallow pond, about 5 feet deep, from which ore has been extracted. Galena and sphalerite were found along the edge of the cut, but no estimate of the amount could be made. The ore horizon here, judging from the openings, is thus probably more than 200 feet wide.

Eight hundred feet north of the Lawn shaft there is an open-cut about 70 feet long and 30 feet wide. At the bottom of this cut there is a shaft, said to be 18 feet deep, from which a 12-foot level has been run north. The exposed ore at the bottom of this shaft is, according to a report by John E. Hardman, over 20 feet wide and dips 50 to 55 degrees west. There is galena and sphalerite at the surface which has been heavily stained by the

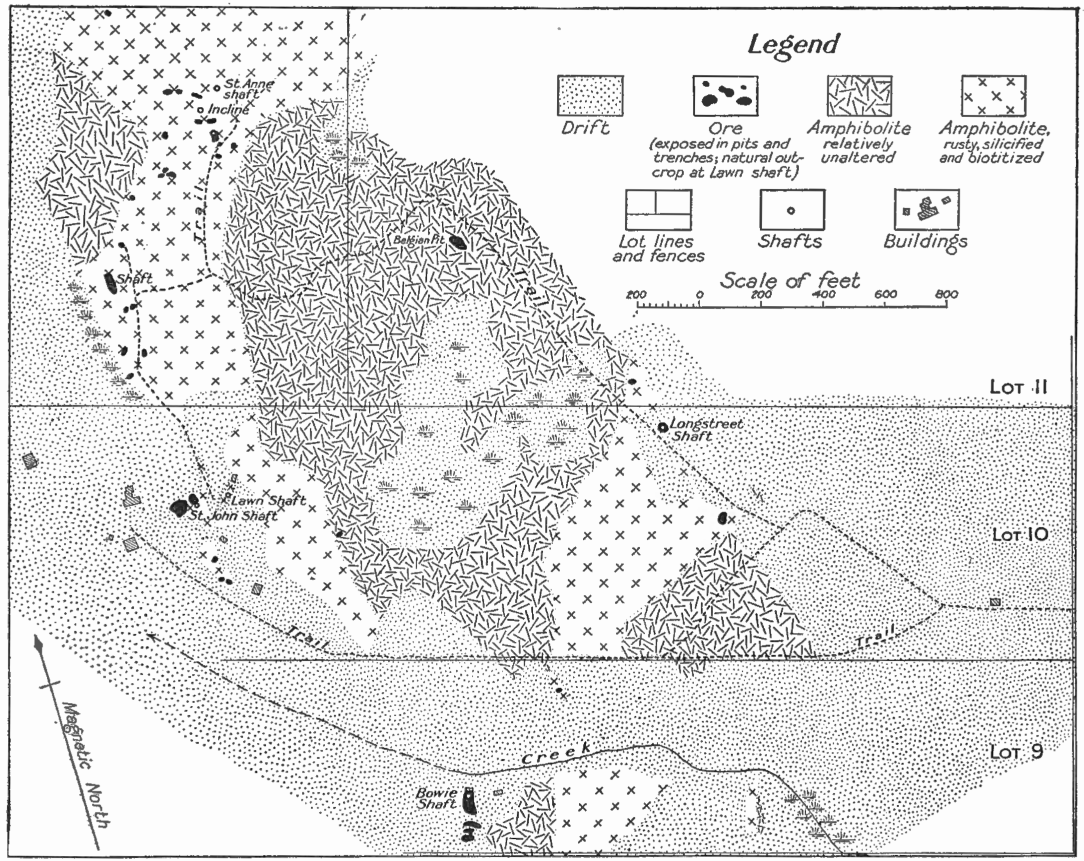

Figure 4. Calumet lead and zinc mine, Calumet island, Quebec.

oxidation of pyrrhotite, but the best ore now to be found here is from the dump, and may represent a lens which enlarges downwards to a maximum size at a depth of 18 feet or more. Between this open-cut and the Lawn shaft are a number of small cuts and trenches. They show pyrrhotite, sphalerite, galena, and, in places, chalcopyrite, scattered in small bunches through a rusty, biotitized, and silicified amphibolite. The average quality of the ore seen was very low grade, but the cuts are not so disposed as to permit of estimating the amount and tenor of the ore.

Six hundred feet north and a little west of the above-described open-cut is the St. Anne shaft which was sunk vertically to a depth of 120 feet, at which depth crosscuts were driven, presumably to the east, to strike the ore lenses on which the shaft had been sunk. The dump from this shaft consists chiefly of calcite impregnated with galena and sphalerite. If the dump is representative of the material extracted from the underground workings, then this is the most promising locality on the property. The type of ore appearing in the materials on the dump does not outcrop.

Eighty feet southeast of the St. Anne shaft an incline has been sunk, but to what depth is not known. There are numerous open-cuts and pits scattered around this incline, which have been made in highly altered amphibolite. They all display sulphides scattered in small patches through the rock. The average ore is low grade. The mineralized area, as indicated by these openings, is about 300 feet wide.

A few hundred feet east of the mineralized zone on which all the foregoing workings are situated is a second zone separated from the first by relatively unaltered amphibolite. On this zone is the Longstreet shaft, stated to be 143 feet deep. It was sunk on the outcrop made by the discoverer of the property. The ore, as indicated by the dump, is galena and sphalerite, which appear to have replaced limestone inclusions in the amphibolite. About 100 feet northeast of this shaft is a small open-cut which displays abundant galena and sphalerite. The width of this ore lens could not be determined.

Nine hundred feet northwest of the Longstreet shaft is an open-cut about 60 feet long, which seems to be about 15 feet deep, but is now full of water. It has been called the "Belgian Pit." The ore extracted here was probably from a narrow galena-sphalerite lens. Some ore still outcrops around the pit, but no large amount is now visible.

The above completes the account of the visible mineralization. The mineralized zone has been trenched and proved to contain sulphide lenses at intervals over a length of about 2,600 feet, and, from indication offered by the outcrops, the zone may continue north for another 400 feet. The zone was traced south over lot 8 and so probably extends across five lots. Over this whole length the outcrops are exceedingly rusty, the rock is heavily biotitized and silicified, and all the cuts contain ore minerals. But because of the irregular, pockety nature of the ore lenses no estimate of the tonnage can be given, and it should not be assumed that productive ore-bodies will be found over the whole zone.

The valuable metals in the ore are zinc, lead, and silver. Locally, galena may be more abundant than sphalerite, but the ratio of sphalerite to galena is, on the average, about as three to one. Samples have been taken at various times and places. Some of the assay results are as follows:

—	1	2	3	4	5	6
Zinc, per cent	29·19	7·58	16·60	15·51	12·30	13·00
Lead, per cent	13·75	4·50	6·64	4·75	3·84	6·00
Copper, per cent	3·17	....	....	....	....	....
Silver, ozs. per ton	14·50	8·90	18·2	13·00	12·00	15·00
Gold, ozs. per ton	....	....	....	....	....	0·03

1. An average sample of the dumps taken in 1911 by C. W. Willimott, of the Geological Survey, Canada.
2. Sample from the Lawn pits from surface to 10 feet depth.
3. Sample from Lawn pits from 10 to 15 feet depth.
4. Sample from Lawn shaft at depth of 57 feet on the incline.
5. Samples from the bottom (18 feet depth) of the Russell shaft.
6. Average of assays on record made by Ledoux and Company, Ricketts and Banks, Cornell University, etc.

The data regarding samples Nos. 2 to 6 have been taken from a private report made by John E. Hardman.

Pyrrhotite and its alteration product marcasite are very abundant. Pyrite, chalcopyrite, and tennantite (?) are present in small amount. Silver seems to be associated with the galena, but the tennantite (?) may be the silver carrier. Tennantite is always associated with, and seems to replace, galena. The order of deposition seems to have been: magnetite, pyrite, sphalerite and pyrrhotite, galena and chalcopyrite, tennantite (?), marcasite.

The amphibolite is a dark green to black, schistose rock consisting chiefly of hornblende and feldspar ranging from albite-oligoclase to labradorite, with apatite, carbonate, garnet, quartz, biotite, magnetite, and ilmenite as accessories. Here and there remnants of diopside, hypersthene, and micropegmatite can be found. In the limestone inclusions calcite has been replaced by diopside, tremolite, scapolite, and apatite. In places the limestone seems to have been rather intimately penetrated by gabbro now altered to amphibolite and in such places the minerals replacing the limestone include diopside-hedenbergite, green hornblende, clinozoisite, scapolite, apatite, calcite, andesine to andesine-labradorite feldspar, and quartz.

Locally, granite pegmatites are present and have caused the formation of microcline, orthoclase, titanite, quartz, zircon, and apatite.

The ore solutions were later than the pegmatite bodies and locally have intensely altered the country rock.

At the immediate boundary of ore masses, amphibolite is practically unrecognizable as such. It is a coarse-grained rock consisting chiefly of phlogopitic biotite and lenses of greasy-looking quartz, with remnants of highly altered feldspar which is near oligoclase in composition. Lesser amounts are present of pleonaste, zircon, sillimanite, apatite, sericite, epidote, chlorite, serpentine, and calcite. The phlogopite is the chief constituent and occurs as large flakes. Pleochroic haloes with small zircon nuclei are scattered abundantly through these flakes. Smaller haloes with apatite and titanite nuclei are present, in lesser amounts. The zircons are thought to be a product of the ore-bearing solutions, although they occur elsewhere in granitized amphibolite and associated with granite pegmatite. The reasons for such a conclusion are as follows. Zircon is present throughout the highly altered wall-rock of the ore zone in greater profusion than elsewhere. It has no local relation to granitized areas nor pegmatite dykes. The zircon, moreover, is confined to the adjacent wall-rock of the deposits and is not found in the amphibolite farther away. Most of the quartz is interstitial between phlogopite grains. Some of the quartz may be primary, but it is relatively unimportant quantitatively when compared with the silicification that has taken place. There is present some pink garnet and a grass-green pleonaste. Pyrrhotite, galena, and sphalerite aggregates are commonly elongated streaks. They replace phlogopite along cleavage planes. Where plagioclase is extensively sericitized, galena is spattered through it as very ragged grains and as perfect crystals extending from narrow veinlets.

Where limestone has been present in the mineralized area, there is greater complication in the mineralogy, due to the presence of additional lime silicates. The dump from the St. Anne shaft is chiefly limestone and limestone with amphibolite occurs at the outcrop east of the Bowie shaft, the dump at the Longstreet shaft, a cut about 400 feet southeast of the Lawn shaft, a small shaft about 125 feet south of the St. Anne shaft, and in the dump from an incline 100 feet southwest of the St. Anne shaft. In the rock of these localities diopside seems to be partly replaced by tremolite. Phlogopite, scapolite, green hornblende, clinozoisite, apatite, andesine, quartz, some titanite, and calcite are present. The feldspar is interstitial between diopside and scapolite, and in places is poikilitic, containing calcite, diopside, and scapolite inclusions. The hornblende is later than diopside and, probably, is usually later than scapolite. Chlorite and serpentine replace diopside and tremolite, but also spread out beyond the boundaries of these grains as an irregular mat and as veinlets of fine-grained aggregates. They seem to be closely related in age to the sulphide minerals. There is both primary and secondary calcite, the primary being very coarse-grained and complexly twinned. The secondary calcite is present as veinlets and as an alteration product of pre-existing minerals. Galena is common and seems to increase with increasing amount of limestone. Where much amphibolite is mixed with the limestone, sphalerite predominates and pyrrhotite is very abundant. The sulphides selectively replace sericitized, chloritized, and serpentinized areas, leaving unaltered diopside and quartz untouched.

Where granite pegmatites are present there is a further complication in the mineralogy. The rock in the dump from the Lawn shaft and the cuts 360 feet southwest and 125 feet south of the St. Anne shaft show much pegmatitic alteration, the amphibolite being feldspathized. At these localities the dykes contain microcline, quartz, phlogopite, apatite, zircon, muscovite, chlorite, serpentine, plumose rods of sillimanite; the amphibolite adjacent to the granite contains highly altered andesine, titanite (now chiefly leucoxene), apatite, garnet, biotite, microcline, quartz, zircon, small sillimanite needles, and the later alteration products such as sericite, serpentine, chlorite, and calcite. Sillimanite replaces biotite and microcline, and is developed where the rock is much sheared. The chlorite is an alteration product of biotite, but extends beyond the boundaries of the mica flakes and also has formed chlorite veinlets in feldspar. The plagioclase is highly altered to sericite, whereas the microcline is relatively fresh except for local replacement by sillimanite. Quartz replaces feldspar and seems to be later than the phlogopite; in many cases it displays a wavy extinction under crossed nicols.

The intensity of alteration of the country rock decreases from the local sulphide-bearing areas. The change is noticeable in distances of 10 to 15 feet. In an outcrop at the west end of the cuts just south of the Bowie shaft, the amphibolite, though heavily biotitized, is still recognizable. The mineralogy consists of pargasite, andesine, biotite forming large plates and small scales along cleavage cracks in amphibole, and apatite. Narrow pegmatite dykes containing quartz and microcline cut through the rock in an irregular pattern.

About 200 feet east of the Bowie shaft the rock is a well-banded amphibolite. The original minerals are light green augite, calcic feldspar, scapolite, apatite, and calcite. The feldspar contains calcite inclusions. Well-formed prisms of clinozoisite are in the scapolite. Calcite veinlets cut these minerals. Little or no later hydrothermal alteration has taken place.

About 550 feet west of the St. Anne shaft the rock is in an incipient stage of alteration and is mineralogically and texturally an amphibolite. The chief minerals are andesine, greenish pyroxene, hornblende, biotite, and small apatite grains. The hornblende is a replacement of the pyroxene, and both are altering to chlorite. There are a little chalcopyrite and other sulphides present. This locality seems to be at about the edge of the area affected by the ore solutions.

QUARTZ-TOURMALINE VEINS

Quartz-tourmaline veins were noted in a few localities. They are rather narrow veins, averaging from 1 to 2 feet in width, and usually consist of coarse, greasy-looking quartz and large, striated prisms of black tourmaline. In the outcrop along the eastern part of lots 2 and 3, range VII, veins of this class contain large crystals of microcline, quartz, and tourmaline, and are intimately associated with granite pegmatites. The tourmaline forms large individuals in the middle of the veins, but towards the wall it is finer grained and in the wall-rock it forms radiating clusters of small tourmaline needles some of which are 10 centimetres long. Farther from the vein, the tourmaline needles are smaller and are accompanied by quartz and, where microcline makes up part of the vein, by pink feldspar.

MOLYBDENITE AND GRAPHITE

On lots 27, 28, and 29, range VII, molybdenite, pyrrhotite, and pyrite occur in amphibolite and limestone in the neighbourhood of pegmatite dykes which also carry molybdenite. This mineral favours areas where diopside-hedenbergite, black hornblende, and biotite have been formed, and it is not found far from the pegmatite body.

Along the line between lots 28 and 29, range VII, about 1,000 feet west of the road, a cut about 60 feet long by 12 feet wide and 7 feet deep has been made in the molybdenite-bearing pegmatite. The cut was full of water when seen and, therefore, the amount of molybdenite present could not be determined. The pegmatite is made up of pink feldspar, quartz, biotite, hornblende, and diopside-hedenbergite.

About the centre of lot 29 a small, rusty outcrop of amphibolite intruded by pegmatite contains flakes of molybdenite disseminated through the rock which is impregnated with quartz and other sulphides, chiefly pyrrhotite. A few pits have been sunk here, but, apparently, without revealing much molybdenite. Flake graphite also occurs at the above-mentioned locality. The graphite of this and all other noted cases is developed in areas around pegmatite dykes. It occurs with phlogopite and a very pale green diopside disseminated through recrystallized calcite. There seems to be a close relation between molybdenite-bearing pegmatite dykes and the graphite deposits. But, whereas the molybdenite accompanies dark-coloured silicates, the graphite occurs with light-coloured silicates as an aureole around the pegmatite dykes. A few cuts have been made in an area holding disseminated flake graphite at the eastern end of lot 27, but neither here nor elsewhere was it observed to be present in sufficient amount to have any commercial value.

OTHER SULPHIDE DEPOSITS

Numerous, narrow pyrrhotite-pyrite veins are scattered through parts of the island. Some of these have been prospected and analyses of samples made at various times. These analyses indicate the presence of gold but in amounts not sufficient for economic exploitation.

In places gabbro and diorite dykes, which cut through limestone, have been extensively mineralized with pyrrhotite and pentlandite. The occurrences observed were: along the northeastern shore of the lake on lot 11, range VIII; the Ostram mineral claim on lot 10, range IX; and at the eastern end of lot 30, range IX. At other places pyrrhotite was seen, and possibly pentlandite also occurs. Open-cuts and pits have been put down at the three first-mentioned places, but are now full of water. A cut 6 feet wide on lot 11, range VIII, has been made in an outcrop so rusty that fresh specimens could not be obtained. The mineralization occurs at the contact of a dyke with limestone and siliceous beds. The most extensive workings are on the Ostram mineral claim where two or three incline shafts have been put down. Ells states that one was reported to be over 70 feet deep, but that " the quantity of the mineral was not sufficient for economic development and the work was abandoned."

The workings lie on a mineralized zone which follows the structure, i.e., north 35 degrees east. The shafts are on the eastern slope of a valley, and, since bedrock in the valley is covered over by swamps and a thick growth of bush, the total extent of the mineralized area could not be ascertained. The outcrop consists of very rusty weathering gabbro and a banded quartzose schist. The gabbro now consists of anthophyllite, serpentine, chlorite, pentlandite, pyrrhotite, magnetite, and a little chalcopyrite. The magnetite is closely associated with the anthophyllite. It is most commonly found filling in the fractures of, and forming a rim around, the anthophyllite, but also occurs as veinlets cutting the pyrrhotite and pentlandite. Pentlandite, pyrrhotite, and chalcopyrite appear to have been deposited in the order named.

BITUMINOUS SHALE AND OTHER MINERAL OCCURRENCES IN THE VICINITY OF SUSSEX, N.B.

By A. O. Hayes

CONTENTS

Illustration

INTRODUCTION

Prospecting for oil in recent years has led to renewed interest being taken in the bituminous shale of the Albert formation south of Sussex. The following report presents the results obtained from a short investigation of the field made late in the field season of 1926. The writer is indebted to Mr. Albert Tribe of Sussex who has located outcrops of the bituminous Albert shale and is thoroughly acquainted with the hill country in the vicinity of Sussex. Mr. Tribe kindly accompanied the writer to a number of these localities, thus greatly facilitating the work.

GENERAL GEOLOGY

Table of Formations

Early Pennsylvanian or late Mississippian	
Mississippian	Windsor formation Albert formation
Pre-Carboniferous group	

PRE-CARBONIFEROUS GROUP

Caledonia mountain extends as a highland from Albert county southwestward into St. John county, rising about 1,200 feet above sea-level. It is composed of volcanic and pyroclastic rocks cut by plutonic rocks and dykes. Locally schists occur. Owing to the resistant nature of the rocks, the highland stood at a higher elevation than the surrounding country throughout Carboniferous time, for the various Carboniferous formations overlap its slopes on all sides and contain pebbles derived from its rocks.

ALBERT FORMATION

The Albert formation is made up of a basal conglomerate, about 650 feet thick along upper Parlee brook, where the strata dip 25 degrees northwest, overlapping unconformably the pre-Carboniferous, igneous rocks of Caledonia mountain. Overlying the conglomerate are interbedded grey sandstones and 6 feet of bituminous shale. This lower part of the series appears to have been preserved locally and the upper part, consisting of at least 1,500 feet of interbedded shale and sandstone, grey and greyish green in colour, present along Moosehorn brook, to have been removed by erosion in the vicinity of Parlee brook before the succeeding formation was deposited.

Along the lower part of Parlee brook, one mile above its forks with Trout brook, bituminous limestone is found holding fossil fish scales plates and a jaw. Similar fossils were found in a prospect pit 5 miles southeast of Sussex along the Cotter Brook road, and in a third locality on a hill top, north of the Friars Nose road forks. W. A. Bell's report on the fossils collected from these localities follows:

"Locality—Parlee brook, about ¾ mile south of its forks with Trout brook and 6 miles east-southeast from Sussex. Collection consists of fragments of a dark grey, micaceous, arenaceous shale that contains abundant fish scales. The majority belong to the genus *Elonichthys* and are perhaps referable to *Elonichthys browni*, a common Albert species. Although these fish scales are not held to be sufficiently diagnostic to affirm positively a Horton age, the common presence of similar scales in the Albert formation would strongly favour their correlation with the Albert.

"Locality—Alonzo Dysart farm, 5 miles southeast of Sussex on the Jerusalem (Cotter Brook) road. Abundant palaeoniscid fish scales, some at least assignable to the genus *Elonichthys*. The lithology of the rock containing the scales and the scales themselves appear to correlate these specimens with those from Parlee brook.

"Locality—Head of Cotter brook, 5 miles southeast of Sussex. Poorly preserved scales of palaeoniscid fishes, including a maxilla similar to that of *Elonichthys*. There seems to be little doubt that the rock represents the same formation as that from the two preceding localities.

"Locality—Ward Creek road 2½ miles south of Sussex. Slabs of coarse sandstone or fine conglomerate contain impressions of decorticated stems of *Lepidodendron corrugatum*. It is concluded that the formation is assignable to the Horton series and hence of pre-Windsor age. Both the Albert and Kennebecasis formations are members of the Horton series and the mere presence of the above species does not warrant a statement as to which of these two formations the Ward Creek beds belong."

About one mile south of Main street, Sussex, a thin-bedded, calcareous shale is exposed in a cutting on the west side of the road. The strata dip 22 degrees east. Poorly preserved fossil plants found there and *Lepidodendron corrugatum* described above, indicate the Horton age of the strata as probably an upper Albert horizon.

Samples from well No. 40 of the Maritime Oilfields Limited were examined. The well was sunk ¾ mile south of Sussex along Ward creek and the log records 1,240 feet of interbedded limestone and shale. The samples indicate a preponderance of a slightly calcareous grey shale similar to that outcropping along the road, and the writer, therefore, concludes that the well is in Albert formation strata, the basal conglomerate of which was not reached. The base of the Windsor formation overlaps the Albert formation between Ward creek and an outcrop of Windsor gypsum

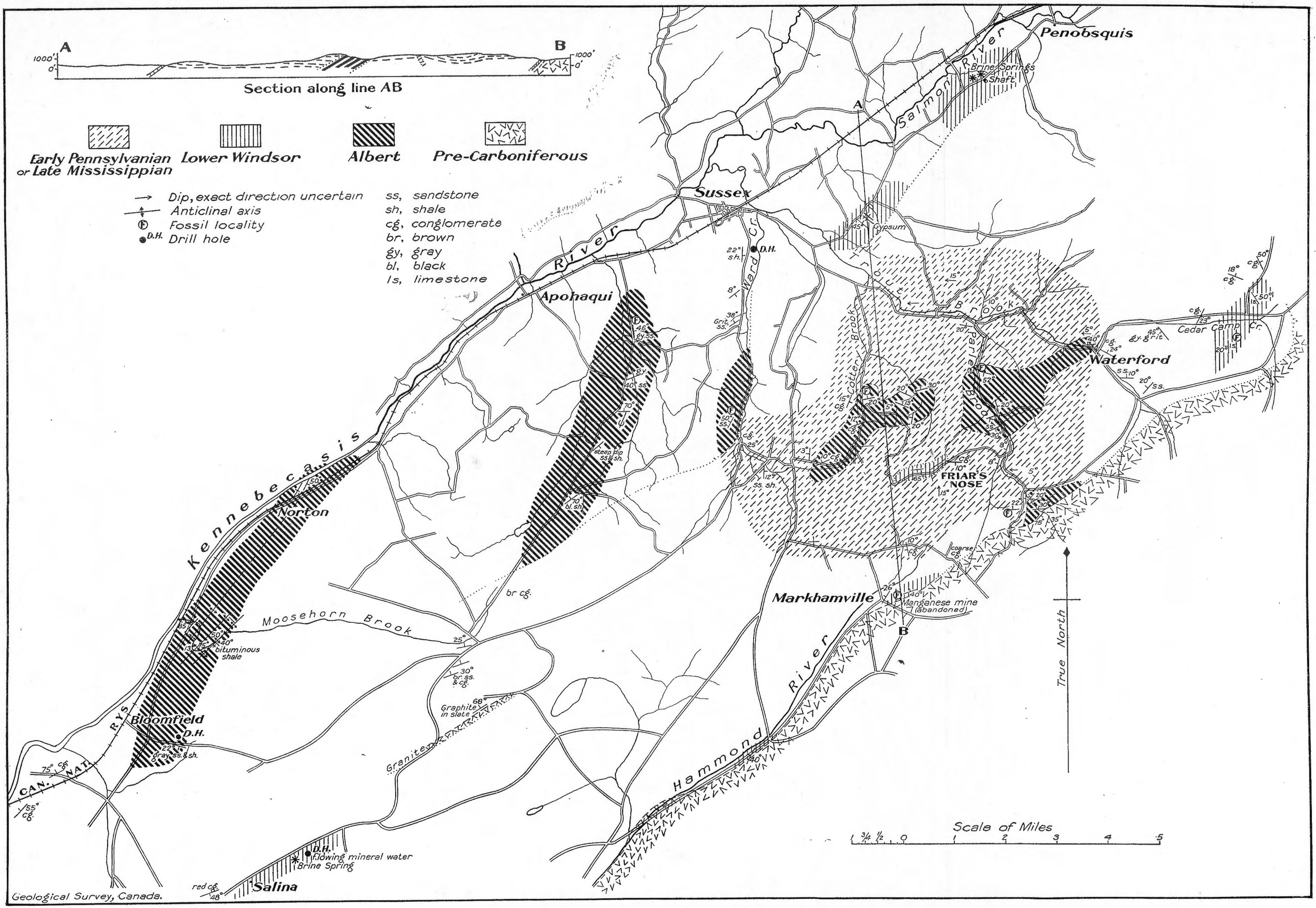

Figure 5. Geology in the general vicinity of Sussex, Kings county, New Brunswick.

2 miles east of Ward creek. The red sandstone and shale outcropping in the east bank of Ward creek may belong to the Windsor, but since the upper part of the Horton series also contains red and brown measures a precise age determination requires more data than was obtained.

Lean, bituminous shale occurs about one-half mile southeast of Moosehorn Brook bridge and one-quarter mile downstream from the ruins of a dam. The shale is exposed on the east limb of an anticline, the axis of which is followed by the brook below the dam. The strata are crumpled and may be faulted. Overlying the shale, well exposed in the canyon-like valley, a thickness of about 1,500 feet of interbedded grey shale, sandstone, and grit occurs between the dam and bridge. The strata are folded in three anticlines.

Ripple-marked, grey sandstone and shale which outcrop one-half mile southeast of Bloomfield resemble the Albert formation and thick-bedded conglomerate and coarse sandstone forming a closely-folded anticline along Kennebecasis river, from Passakeag to Hampton, suggest basal Albert. The relationship between the last-mentioned strata and the softer red shale sandstone and conglomerate of the Kennebecasis formation exposed along the St. John highway, both east and west of Hammond river, has not been definitely established. It appears probable that the Kennebecasis formation, stretching from Hampton westward along the Kennebecasis to St. John river, overlies the Albert formation.

WINDSOR FORMATION

The Windsor formation is represented by limestone containing typical Windsor fossils, and by gypsum deposits and brine springs. The log of a boring at Salina post office indicates interbedded gypsum and red sandstones and shales, but no typical section representative of the formation was seen by the writer in the locality under discussion.

At Markhamville, in the workings of an abandoned manganese mine, the following section was measured:

	Feet
Massive limestone, fossiliferous, top eroded	24
Lenticular bed of limestone	1 to 3
Massive limestone in which deposits of manganese oxide occur	6
Thin-bedded limestone	2
Massive limestone	6

Fossils were collected from the limestone in place and from the old mine dumps, in the years 1915 and 1919. A report by W. A. Bell upon these collections follows:

"*Report on Fossils Collected from Markhamville, New Brunswick, by Messrs. Hayes, Wright, and Bell in 1915 and 1919*

By W. A. Bell

Lot No. REMARKS

5020 Reddish grey limestone and conglomerate containing pebbles of igneous rock. Carries small crystallized aggregates of manganite.
Fossils: *Dielasma latum*[1] Bell

5022 Reddish grey limestone.
Fossils: *Dielasma* sp. Too poor for specific identification.

[1] Manuscript name.

5473 Reddish grey limestone, abundantly fossiliferous, but fossils commonly enclosed in heavy coatings of concretionary limestone.
Fossils: *Dielasma latum*[1] Bell, very abundant

5474 Reddish grey limestone with crystallized aggregates of calcite and manganite.
Fossils: *Conularia planicostata* Dawson
Dielasma latum[1] Bell

5475 Reddish grey limestone, in part dense, in part like 5473.
Fossils: *Conularia planicostata* Dawson
Productus, specifically unidentifiable
Dielasma latum[1] Bell, abundant
Sanguinolites parvus[1] Bell
Pteronites gayensis Dawson
Pteronites ornatus Dawson
Aviculopecten, specifically unidentifiable
Pseudamusium simplex (Dawson)
Lithophagus avonensis[1] Bell
Spathella insecta (Dawson)
Cyclonema cf. *subangulatum* Hall

5476 Grey and reddish grey mottled limestone.
Fossils: *Dielasma latum*[1] Bell

5477 Reddish grey limestone with crystallized aggregates of manganite and calcite.
Fossils: *Conularia planicostata* Dawson
Dielasma latum[1] Bell

5478 Reddish grey limestone like 5477
Fossils: *Conularia planicostata* Dawson
Dielasma latum[1] Bell, abundant
Leptodesma borealis Beede
Pteronites gayensis Dawson

5479 Reddish grey limestone like 5477
Fossils: *Conularia planicostata* Dawson
Dielasma latum[1] Bell
Leptodesma borealis Beede
Pteronites gayensis Dawson

5480 Grey, fossiliferous, manganite-bearing limestone. A few small pebbles of dark grey micaceous shale. Abundantly fossiliferous, but preservation generally poor.
Fossils: *Parallelidon dawsoni* Beede
Pteronites ornatus Dawson
Aviculopecten lyelli Dawson
Zygopleura sp.

5481 Reddish grey, dense limestone, and mottled reddish and grey limestone with crystals and crystallized aggregates of calcite and of manganite. Either of the latter commonly fill the interiors of fossil shells.
Fossils: *Conularia planicostata* Dawson
Dielasma latum[1] Bell, abundant
Leptodesma dawsoni (Beede)
Turbina? sp.

5482 Rock identical with that of 5480
Fossils: *Zygopleura* sp., abundant

5483 Light grey limestone
Fossils: *Dielasma latum*[1] Bell

5484 Grey limestone with calcite aggregates
Fossils: *Dielasma latum*[1] Bell

[1] Manuscript names.

The lithological, as well as the faunal, characters of the various lots all indicate a single faunal zone. The complete faunule of identifiable species, therefore, is as follows:

Vermes? —*Conularia planicostata* Dawson
Brachiopoda—*Dielasma latum*[1] Bell
Pelecypoda —*Sanguinolites parvus*[1] Bell
Parallelidon dawsoni Beede
Leptodesma borealis Beede
Leptodesma dawsoni (Beede)
Pteronites gayensis Dawson
Pteronites ornatus Dawson
Aviculopecten lyelli Dawson
Pseudamusium simplex (Dawson)
Lithophagus avonensis[1] Bell
Spathella insecta (Dawson)
Gastropoda —*Cyclonema* cf. *subangulatum* Hall
Turbina? sp.
Zygopleura sp.

The age of the faunule is unquestionably lower Windsor and, therefore, about equivalent to lower Chesterian in the Mississippian region or lower Viséan in the European succession. Of the above species only two, viz., *Turbina?* sp. and *Zygopleura* sp., have hitherto not been recognized in the Windsor fauna at Windsor, Nova Scotia. Moreover, the faunule is identical with that held by the Miller Quarry and Maxner Point limestones of Windsor and, accordingly, the containing beds represent an equivalent stage in the lower Windsor. The preponderance of pelecypoda in the Markhamville faunule is quite in harmony with the abundance of members of this class of organisms in the corresponding Windsor strata."

East of Friars Nose, 200 yards north of the road between the farmhouses of Messrs. Talot Arnold and William Proctor, bituminous limestone outcrops, in which a prospect pit was sunk by Mr. Albert Tribe. The working exposed 10 feet thickness of sparingly fossiliferous limestone underlain by grey sandstone not well exposed. The strata dip 85 degrees south. Mr. Bell reports as follows on the fossils:

"A dark and finely nodular bituminous and pyritous limestone sparingly contains *Dielasma davidsoni,* denoting a Windsor age."

In an overlying stratum of impure limestone, dried petroleum in cracks in the rock suggested Albert formation conditions, but the limestone is lithologically different from the Albert limestone and no fish remains were discovered in it, so that the conclusion is reached that the hill-side at this locality is underlain by Windsor strata.

Cedar Camp creek was visited by the writer, in company with W. J. Wright, in 1919, when the following notes were taken. About 3 miles east of Waterford at the forks of Cedar Camp creek, vertical cliffs expose conglomerate overlain by fossiliferous limestone. On Thos. Gray's farm a thickness of 10 feet of nodular limestone is exposed dipping at 50 degrees to north 75 degrees east. Conglomerate occurs above and below the limestone, the actual contacts being soil-covered. The attitude suggests an interbedded sequence. On J. Powell's farm south of the brook, a rocky bluff of conglomerate visible from the road is overlain by limestone from

[1] Manuscript names.

which a collection of fossils was obtained. These were examined by Dr. G. H. Girty, who reports as follows:

"*List of Species*

Beecheria davidsonia
Pteronites gayensis
Liopteria (Leptodesma?) dawsoni
Aviculopecten simplex
Pleurotomaria sp.
Orthoceras sp.
Conularia planicostata

Inasmuch as the geologic age of this fauna was at one time called in question I may say that in my opinion it is unequivocally Mississippian rather (than) Pennsylvanian and probably also Upper Mississippian. It is true that the present collection does not contain many forms one would call characteristically Mississippian (*Pteronites gayensis* is perhaps the most significant), but this incomplete presentation of the fauna can be supplemented with other species described by Dawson and more recently by Beede, so that little doubt can exist regarding the evidence of the invertebrate fossils."

Four miles southwest of Markhamville, at Fowler Corner, the Windsor limestone is again met with. The exact location is 100 yards south of the schoolhouse on the east side of the road, and ¼ mile south of the Shepody road forks. The limestone outcrops again ¼ mile farther southwest and has a dip of 40 degrees north 60 degrees west.

The gypsum deposits at Upham, and between Sussex and Plumweseep, are thought to form part of the Windsor strata, for similar deposits occur in the known Windsor at Hillsborough and are not known in other geological horizons in eastern Canada.

EARLY PENNSYLVANIAN OR LATE MISSISSIPPIAN

Above the Windsor formation and overlapping unconformably upon the Albert formation, is a red conglomerate having at its base a limestone holding fossils of concretionary algæ. Similar limestone is known to the writer only at cape Demoiselle, Albert county, and there it is associated with conglomerate in which worn pebbles of limestone contain the lower Windsor fossil *Dielasma*, indicating a post lower Windsor age, either late Mississippian or early Pennsylvanian. The formation is best seen in Friars Nose hill, west of the upper part of Parlee brook, where a thickness of about 700 feet of conglomerate overlies the Albert formation.

ECONOMIC GEOLOGY

BITUMINOUS SHALE

The bituminous Albert shale was sampled at two localities. The first sample was taken from the Alonzo Dysart farm about one mile east from the forks of Cotter Brook road and the Friars Nose road. The outcrop was in the bank of a small stream and consisted of crumpled shale. The samples represent about 5 feet of strata. The result gave approximately 10 imperial gallons of oil to the ton of 2,000 pounds.

The second sample was taken from Waterford, about 9 miles east-southeast from Sussex, from the north bank of Trout brook at a point ¼ mile downstream, west of Moores bridge. The results of the analysis made by Mr. Swinnerton of the Fuel Testing Division of the Mines Branch is as follows, the results being stated in imperial gallons per ton of 2,000 pounds:

Sample 3 from upper 3 feet strata..........................	3·3 gallons per ton
" 2 from middle 2 feet strata........................	6·4 " "
" 1 from lower 3 feet strata..........................	10·6 " "

The full thickness of the bituminous shale zone was not seen as the water of the brook covered the basal strata. The occurrence of oil-shale along Ward creek is noted in former reports, but no analyses are recorded. No shale having the appearance of being of a higher quality than those sampled was seen by the writer.

As already stated, the bituminous shale occurs in the lower part of the Albert formation in a series of sandstones overlying a thick basal member consisting of conglomerate.

GRAPHITE

Graphite occurs on the farm of John McCarron, about 8 miles southeast of Norton, at the summit of a hill near the headwaters of Moosehorn brook. Southfield or Campbell settlement is one mile north of the graphite prospect. As yet insufficient work has been accomplished to determine the value of the deposit and development of the prospect would be expensive.

The graphite is associated with black slate which dips north 30 degrees west at an angle of 68 degrees, and is in faulted contact with granite. Several hundred feet of shallow trenching, done some years ago, reveals a width of about 150 feet in which zones of workable graphite may be found. At a distance of about 1,000 feet north 60 degrees east along the line of strike of the strata, a pit was sunk, said by Mr. John McCarron to be 12 feet deep.

SALT AND MANGANESE

Salt was formerly manufactured from brine springs at Plumweseep and Salina. These persistent springs suggest the presence of rock salt in the Windsor strata.

A considerable tonnage of manganese ore has been mined from the Windsor limestone at Markhamville and other deposits of manganese ore may occur.

L'ETANG LIMESTONE DEPOSIT, CHARLOTTE COUNTY, N.B.

By W. L. Uglow

Illustration

The L'Etang limestone deposit is located on L'Etang peninsula, Charlotte county, New Brunswick, about 5 miles south of St. George, on the St. John-St. Stephen line of the Canadian Pacific railway. It is accessible by a good motor road from St. George, or by vessels of any draught from L'Etang harbour on Passamaquoddy bay. The deposit extends in an easterly direction across the peninsula and forms one-third of its coastline. The deposit is owned by J. Sutton Clark of St. George.

The accompanying figure shows the topography of the peninsula, the distribution of the limestone, the location of the old quarries, and the points at which the samples described in this report were taken.

The following statement concerning the geology of the area underlain by L'Etang limestone is made by R. W. Ells.[1]

"The interesting band of crystalline limestone which occurs on Frye island, and which, after crossing from the south to the north, extends across the passage to L'Etang peninsula, and appears in a broad belt just west of L'Etang village, was carefully examined. It has been regarded as representing the crystalline limestones of the Laurentian as developed about St. John, but from the fact that it is closely associated with slates, now schistose, of Silurian age, and in places contains fossil corals and other forms at several points, the geological position formerly assigned to it must now also be changed. The crystalline limestones show several stages of alteration, and in places where the alteration has not been so complete, an abundance of fossil shells with corals was found. The highly crystalline portion gradually shades off into bluish and less altered limestone, and the peculiar green and purple shales and sandstones of Silurian age are clearly a part of the limestone series."

Three main varieties of limestone occur in the deposit: (*a*) fine-grained, pure white marble, in places mottled with greyish blebs and streaks constituting as much as 60 per cent of its volume; (*b*) dark, greyish-weathering, fine-grained, grey to greyish-white, thin-bedded limestone, with small amounts of carbonaceous matter; (*c*) interbedded argillite and grey limestone. This latter type includes the "crenulated argillaceous limestone" and the "argillite, calcareous in part" of the legend of Figure 6.

(*a*) WHITE TO MOTTLED WHITE AND GREY MARBLE

One belt of marble lies alongside the argillite that bounds the limestone deposit on the southeast. Intermittent exposures indicate that this belt has a longitudinal extent of at least half a mile in a northeasterly direction, but its width could not be accurately ascertained except in the

[1] Ells, R. W.: "Charlotte County, N.B."; Geol. Surv., Canada, Sum. Rept. 1903, pt. A, pp. 154-155.

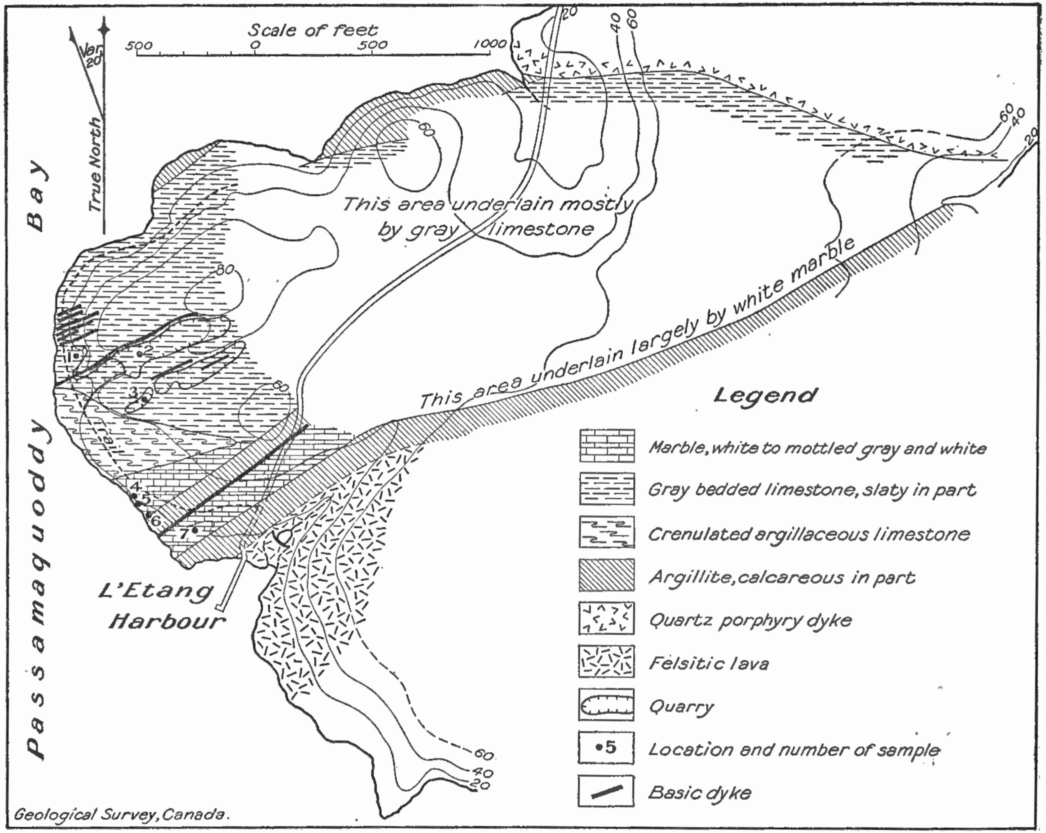

Figure 6. L'Etang limestone deposit, Charlotte county, New Brunswick.

southwestern part. The marble and the argillite strike north 55 degrees east, and dip from vertical to 85 degrees northwest. Consequently, it may be safely assumed that the width at the outcrop will be maintained to at least a moderate depth.

At its southwestern extremity this belt is about 110 feet wide, and consists largely of thinly-bedded grey and white marble of good grade. The thin bedding gives rise to a somewhat slaty fracture causing the marble to break into sheets about one-half inch thick. This seems to be mainly a surface phenomenon, and it is likely that the rock will become tighter and more compact in 30 or 40 feet of depth. Assuming an average width of 100 feet and a length of one-half mile, there would be approximately 400,000 tons of rock in this belt above mean sea-level. Analysis No. 7 in the following table is from a 10-foot continuous sample taken across the strike, and is representative of a width of 80 to 100 feet.

Another belt of marble occurs along the southwest shore of the peninsula, between an elongated belt of argillite and a triangular mass of crenulated, argillaceous limestone. This body of marble is wedge shaped. It is not very extensive, and, from an exposure of 220 feet wide along the shore, it tapers inland to a point in a length of 500 feet. The bedding is nearly vertical, thus indicating that the horizontal dimensions of the mass remain constant for a considerable depth. In this belt is some of the purest limestone of the peninsula. In this wedge-shaped mass there would be about 140,000 tons above mean sea-level.

Three samples (*See* table of analyses), described as follows, were taken from different parts of the belt:

No. 6. 10-foot continuous sample taken across white, thinly-bedded marble, representative of 60 feet of width.
No. 5. 10-foot continuous sample taken across pale grey, massive, mottled marble, not markedly bedded, representative of 25 to 30 feet of width.
No. 4. 10-foot continuous sample taken across greyish-white, poorly-bedded marble, mottled white and grey, representative of about 150 feet of width.

(*b*) DARK GREYISH-WEATHERING BEDDED LIMESTONE

By far the largest part of the deposit consists of this type of limestone. It underlies about 62 acres and has a marked slaty fracture (bedding joints) with a nearly vertical dip. This structure indicates that for some depth at least there would be no diminution in the horizontal extent of the beds.

No white marble is present in this area. The slaty fracture so evident at the surface seems to disappear at a depth of 20 to 30 feet, as shown by the bottoms of the old quarries where the limestone is fairly massive.

The limestone is cut by a series of basic dykes and sills, which could be eliminated during quarrying operations. Apart from these, the only impurities that are visible to the naked eye are minute flakes of carbonaceous material that produce the dark grey colour, and make a marked black sediment when the rock is dissolved in dilute hydrochloric acid. Towards the northwest side of the deposit the grey limestone becomes argillaceous through gradation to argillite, and the basic dykes and sills become more numerous.

On the assumption that at least one-half of the limestone underlying the 62 acres is of mineable grade, there would be about 5,000,000 tons of it above mean sea-level.

Three samples were taken from the floors of the old quarries, as follows:

Nos. 1, 2, 3: 10-foot continuous samples taken across the bedding of dark grey, non-slaty, bedded limestone, representative of a width of 400 feet.

(c) INTERBEDDED ARGILLITE AND GREY LIMESTONE

Four belts of this material occur within and along the margins of the main limestone deposit. They are outlined on Figure 6, but were not sampled.

ANALYSES OF LIMESTONES

—	1	2	3	4	5	6	7
Insoluble matter......	2·90	4·06	2·20	2·10	1·20	1·60	4·16
Fe_2O_3..................	0·44	0·49	0·37	0·41	0·29	0·33	0·53
Al_2O_3..................	0·86	0·81	0·53	0·75	0·71	0·57	0·77
$CaCO_3$................	94·82	93·98	96·53	95·91	97·00	96·62	93·98
$MgCO_3$................	1·17	1·12	0·88	0·96	1·09	1·00	0·96
Total.........	100·19	100·46	100·51	100·13	100·29	100·12	100·40
CaO..................	53·10	52·63	54·06	53·71	54·32	54·11	52·63
MgO..................	0·56	0·54	0·42	0·46	0·52	0·48	0·46

Nos. 1, 2, 3: 10-foot continuous samples of dark grey, bedded limestone.
Nos. 4, 5, 6, 7: 10-foot continuous samples of mottled, white and grey marble.
The samples were dried at 105°C. The analyses were made by H. A. Leverin, Mines Branch, Dept. of Mines, Canada.

THE GEOLOGY OF PARTS OF EASTERN ARCTIC CANADA

By L. J. Weeks

CONTENTS

Illustrations

INTRODUCTION

The field season of 1925 was spent by the writer as representative of the Geological Survey on the C.G.S. *Arctic* during her annual cruise to northern waters. Though it was fully appreciated that no detailed work could be accomplished during the brief stops of the ship, yet it was thought that general information of both a scientific and practical nature might be obtained that would be of service to a survey party wintering in the north at a future date. The ship made seven calls on this cruise, two being in Greenland. Sixteen days were spent in harbour on the Canadian side, and two in Greenland. The longest call at one place was five days. From 1 p.m. July 18, until midnight August 6, the *Arctic* was held in a large ice field off cape Mercy, Baffin island. The daily progress during this period varied from 2 to 15 miles a day, the ship being at rest a great deal of the time.

The writer wishes gratefully to acknowledge the aid and co-operation extended by Mr. G. P. MacKenzie, commander of the expedition, also by Captain Bernier, and officers and members of the staff of the C.G.S. *Arctic*. Through the interest of Mr. MacKenzie a special stop was to have been made at Blacklead island, Cumberland gulf, to permit an examination of the graphitic rocks exposed there. Adverse ice conditions, however, made such a step impracticable.

FRAM HAVN, EAST CENTRAL ELLESMERE ISLAND

Fram Havn (*See* Plate II A) is a small inlet on the west side of Rice strait, a narrow passage averaging 2 miles in width and separating Pim island on the east from Ellesmere island on the west. The topography is rugged and the mountain slopes are covered with an ice-cap which descends to the sea in numerous places, as at the head of Fram Havn where an arm of the ice-cap presents a wall of ice a quarter mile wide. To the north in Kane basin, Bache peninsula may be seen as a long point of ice-free land projecting beyond Buchanan sea. Its freedom from an ice-cap may be ascribed to its narrow width, a sufficient area not being presented for the support of ice accumulations.

The predominant rock in the region is a grey granite gneiss. Included masses of fine, dark, siliceous sediments are found, and the intrusive nature of the granite gneiss is shown by the manner in which the latter invades the sediments with dykes and tongues of finer-grained granitic material. Microscopically, the granite gneiss is seen to be composed of microcline and quartz with some chlorite and magnetite. Recrystallization has taken place in some cases and a faint banding is perceptible. The sediments are composed predominantly of rounded quartz grains with some fragments of what was probably a basic igneous rock.

The limestones which are found overlying the older rocks farther south were not observed at Fram Havn, but are found farther north on Bache peninsula. However, rounded pebbles of buff-coloured limestones are common in the accumulations of glacial debris hereabouts, and it might be assumed that they overlie the older rocks farther inland.

CRAIG HARBOUR, SOUTHERN ELLESMERE ISLAND

This region, like that in the vicinity of Fram Havn, is quite mountainous and covered with an ice-cap. Cliffs rise steeply from the sea to heights of around 1,000 feet, above which the surface continues to rise inland. At the head of Craig harbour is a flat plain, 2 or 3 miles wide and extending about 4 miles inland. This plain is composed entirely of detrital materials from the glacier at its head, and numerous streams from the glacier cross it to the sea (*See* Plate III).

The cliffs are composed of a reddish, coarse-grained granite in a fresh, unaltered condition. Microscopically, it is seen to be a coarse-grained intrusive composed predominantly of quartz and microcline, with few ferromagnesian minerals. The only evidence of deformation visible under the microscope is a slight straining of the quartz crystals, resulting in a wavy extinction.

At heights of about 1,000 feet is found a fine, buff-coloured limestone. The contact is everywhere at the same general elevation and the attitude of the beds is very nearly horizontal. No fossils were found, although several fossil-like concretions were collected.

DUNDAS HARBOUR, NORTH DEVON ISLAND

The northeast and southeast shores of North Devon island are mountainous and covered with a considerable ice-cap. Philpots island on the east coast is, however, low over a considerable part of its area. This feature may be due to the presence of softer rocks underlying the low part, or the low part may be a wave-cut terrace, since uplifted.

Dundas harbour, a fiord at the eastern extremity of Croker bay, extends inland 5 or 6 miles and is about 2 miles wide. A river flowing from a glacier some 5 or 6 miles back enters at the head. In this vicinity cliffs rise abruptly from the sea to heights of over 1,000 feet, above which a rising slope continues inland. On the east side of Croker bay, some 6 or 8 miles west of Dundas harbour, a broad plain, less than 100 feet above sea-level, and in places 3 miles wide, lies between the sea and the cliffs (*See* Plate II B). This plain is covered with rounded pebbles of undoubted littoral origin. Remains of Eskimo dwellings are found at the base of the cliffs and inland over a mile. Present day Eskimos of this area do not build their houses at any great distance from the sea, their great provider. If the ancient Eskimo tribes also followed this custom, it would seem as if the uplift of this wave-cut beach was later than the habitation of the country by Eskimo.

The cliffs and rock exposures along the shore of Dundas harbour are composed of a grey, well-banded gneiss. The banding is due to differences in composition and individual bands have great persistence along the strike. The dip is low, ranging from 5 degrees to 45 and 50, although steeper dips occur locally. From a study of these rocks in the field, a sedimentary origin seems to be applicable. In thin section, very little was observed that would cast light on this question. The rock is highly metamorphosed, and is composed of quartz, feldspars, and mica. Dykes of dense, dark, diabasic rocks cut these gneisses along the shore of Croker bay.

At the top of the cliffs, at elevations of 900 feet, and at gradually decreasing elevations to the westward, occurs flat-lying, light buff-coloured limestone. Numerous fossil-like concretions were collected, which on subsequent examination proved to be non-organic in origin. This limestone group, as mentioned, dips slowly to the westward, and is the predominant rock west of cape Bullen. A distinct erosional unconformity exists between this group and the gneisses below.

PONDS INLET, NORTHERN BAFFIN ISLAND

The greater part of northern Baffin island is high and rugged, covered with an ice-cap, and rising steeply from the sea. South of Eclipse sound is an area of low, flat country or rolling hills a few hundreds of feet high, and separated abruptly from the highlands. Similar flat, rolling country forms a narrow border to the west coast of Bylot island, the greater part of which is high, like Baffin island, and with a considerable ice-cap.

The low plain south of Eclipse sound has been dissected by streams to depths of 40 to 60 feet, the streams usually flowing in narrow, steep-walled gorges. On this plain, outcrops are extremely scarce, or lacking, but may usually be found on the walls of the stream valleys. The highlands of northern Baffin island are essentially of bare rock which in most places occurs in huge blocks, formed in situ.

The highlands are composed of an old complex of gneisses and granites which appear to be a continuation of the older rocks exposed on the islands to the north. The low country on the south side of Eclipse sound is underlain by much younger sediments consisting of fine-grained, grey, crossbedded sandstones, and some conglomerates. Included in these measures are numerous seams of lignite or low-grade bituminous coal. On the seacoast fronting this belt of later sediments are occasional outliers of the older complex, so that the thickness of the sediments cannot be very great. Fossils have not been described from this particular locality, but elsewhere in the Arctic archipelago similar strata, also containing seams of lignite, bear Tertiary fossils. Low[1] considers this evidence sufficient to ascribe to these rocks a Tertiary age. Fossil plants were observed by the writer, but in a very badly weathered condition, and no opportunity was presented for collecting them. Similar rocks occur on the west coast of Bylot island, and coal has been found at Canada point and at cape Hay.

COAL AT SALMON RIVER

Coal has been known at Salmon river for over twenty years and traders and explorers have there replenished their fuel supplies. The first mining lease on the coal measures was issued in 1923 to Gaston Herodier, post manager of the Hudson's Bay Company at Ponds Inlet. This lease was later transferred to the company. About 50 tons a year is mined from the exposures in the river cliff, and is carried to the post by dog-team.

Salmon river enters Eclipse sound 2 or 3 miles west of the settlement of Ponds Inlet. Broken coal occurs in the river bed and doubtless led to the discovery of the exposures. The first outcrop of coal to be seen on ascending the river occurs near the No. 1 post of the Hudson's Bay Company's lease. Coal has been mined by Captains Bernier and Munn at a point a mile or so downstream from this cropping, but these older workings are now completely caved in. The exposures, near the present mining lease, which are now the only ones worked, are about 2½ miles from the mouth of the river. The coal is well exposed in a cliff facing the river, and is about 150 feet southwest of the No. 1 post. Two main seams are exposed, in addition to several seamlets an inch or so thick. The attitude of the beds is horizontal or nearly so. The country rock is a grey, crossbedded sandstone, varying in texture from very fine to conglomeratic. The coal, owing to the ease with which the rocks weather, is exposed only where the river is undermining the bank and carrying away the debris and for this reason coal exposures are very few. Weathered coal is found in many places on the sides or tops of knolls in the surrounding country. From the attitude of the beds and the character of the topography it is extremely probable that many additional exposures could be obtained by trenching.

The upper of the two main seams exposed in the river bank is shaly and weathers readily to crumbly cleavable fragments. This seam has not been mined. Its crumbly nature may be due to its greater exposure to freezing and thawing, since there is very little overburden; or it may be an inherent characteristic of the coal. The lower seam is the one at present utilized by the Hudson's Bay Company. When freshly dug it

[1] Low, A. P.: "The Cruise of the Neptune"; 1903-4, p. 229 (1906).

breaks into irregular lumps exhibiting nothing resembling a cleavage plane. After being sacked and left some months in the open, it tends to crumble, but this tendency is by no means as great as that possessed by the coal of the upper seam. The coal is a dull black, with here and there a bright surface, which upon examination appears to be the fossilized stem of a tree or shrub. Both seams are 3½ feet thick.

REPORTED COAL OCCURRENCES IN THE EASTERN ARCTIC

Tertiary coals have been long known at Salmon river, Eclipse sound, and at Canada point and cape Hay, Bylot island.

Parry and Liddon found coal on the shores of Liddon gulf, Melville island. Peat and coal were reported by men of the C.G.S. *Arctic* near Phipps point, 12 miles east of Winter harbour. They also report loose coal on the beach between Fife harbour and Winter harbour, Melville island. Bituminous shale was found on the shore of Chevalier bay.

Chief Officer Green of the *Arctic* reports a large seam of coal on the east side of Rodd head, north shore of Banks island. Coal was also reported by R. J. L. M'Lure on the middle of the west shore of Mercy bay, Banks island.

Small pieces of coal were found by F. L. M'Clintock on the south shore of Byam Martin island, and also on Bathurst island on the shores of the most southerly arm of De la Beche bay and the shore northwest of Scoresby bay. Coal was also found at Sargent point, Bathurst island, by Commander G. H. Richards, when searching for Franklin.

On the west coast of Ellesmere island coal has been found in many places. Sverdrup reports it in Baumann fiord and Stenkul fiord. Sir G. Nares reports coal on the east coast of Ellesmere island near cape Murchison, lake Hazen, and at Watercourse bay. The latter occurrence he describes as a seam exposed through a thickness of 25 feet and a length of 300 feet. The bottom of the seam is unexposed.

The geological relations of many of these occurrences are quite obscure, but without doubt most of them are outliers of Tertiary sandstones and shales.

PANGNIRTUNG, SOUTHERN BAFFIN ISLAND

Southern Baffin island may be divided into two physiographic provinces, the granitic highlands and the sedimentary lowlands. The former do not vary much in height or character from those of northern Baffin island. The lowlands form a belt extending from the west coast on Foxe channel, almost to the heads of Cumberland gulf and Frobisher bay on the east coast of the island. Two large lakes occur in this low country, Amadjuak lake on the south and Nettilling lake on the north, both draining to the sea at Foxe channel through Koukdjuak river. Nettilling lake is only a few miles from the head of Nettilling fiord on Cumberland gulf, and the divide rises only a couple of hundred feet above sea-level. These lowlands are free of snow in the summer and support considerable vegetation. Large herds of caribou are found here and it is a favourite hunting ground for the Eskimo.

The writer spent a few days at Pangnirtung fiord, at the head of Cumberland gulf. The rocks here belong to a complex of older gneisses and schists and resemble in most respects the rocks of the complex found in the northern part of the island. Some deposits of non-metallic minerals have been reported from this region, and attempts have been made to mine graphite and mica.

The interior lowland belt is underlain by limestones and other sediments. These rocks in many places are fossiliferous.

Schuchert, in 1900, described a collection of seventy-two species from Silliman mount, head of Frobisher bay.[1] He concluded that the fossils of the collection were all of about Galena-Trenton time. In 1914 Schuchert again studied a collection from southwestern Baffin island, near Rescue harbour.[2] He recognizes three horizons, two Ordovican and one Silurian.

REPORTED MINERAL OCCURRENCES IN SOUTHERN BAFFIN ISLAND

Graphite has long been known to exist at Blacklead island, Cumberland gulf. Bell, in 1897, mentions receiving specimens here.[3] Low[4] describes the rocks of this island as coarse-grained, pink mica-granite-gneiss cutting and interbanded with coarse, dark mica schists and finer-grained quartzose gneisses. He also states that graphite is abundant in places on the islands and shores of the gulf farther west. Blacklead island is about 3 miles long and has long been the seat of whaling operations in Cumberland gulf.

In 1916 the Hudson's Bay Company commenced the development of a graphite deposit near Lake harbour, behind Big island on the south shore of Baffin island, and in 1917 and 1918 shipped a small tonnage. The graphite is of the crystalline or vein variety, the veins occurring in crystalline limestone at its contact with intrusive quartz dykes.[5]

Inspector C. E. Wilcox, R.C.M.P., who spent the winter of 1924-25 at Pangnirtung, tells the writer that sometime in the latter part of the last century an attempt was made to mine mica on a fiord at the head of Cumberland gulf, about 40 miles from Pangnirtung. A narrow-gauge railway is said to be there yet. This mineral has also been mined near Lake harbour.

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1 Schuchert, Chas.: U. S. Nat. Mus., Pr. 22, pp. 143-178 (1900).
2 Schuchert, Chas.: Am. Jour. Sci. (4) 38, pp. 467-477 (1914).
3 Bell, R.: Geol. Surv., Canada, Ann. Rept., vol. XI, pt. M, p. 20 (1901).
4 Low, A. P.: "Cruise of the Neptune", 1906, p. 204.
5 Spence, H. S.: "Graphite"; Mines Branch, Dept. of Mines, Canada, 1920, p. 61.

INVESTIGATION OF PEAT BOGS IN NEW BRUNSWICK

By A. Anrep

CONTENTS

Illustrations

INTRODUCTION

Nine peat bogs in New Brunswick were investigated during 1925. These nine bogs, with a combined area of 8,742 acres, are suitable for the production of peat litter. They lie in Northumberland and Gloucester counties, on or close to the shore of Miramichi bay. A. Phelan acted satisfactorily as field assistant.

During the past years spent in the Maritime Provinces in connexion with the investigation of peat bogs, it has been found that peat litter bogs were the most prevalent. The best and largest of these were found in northern New Brunswick, in the counties of Northumberland, Kent, and Gloucester. A number of smaller bogs are known in Nova Scotia, mostly in Guysborough county. Good peat fuel bogs are very scarce.

BURNT CHURCH PEAT LITTER BOG, ALNWICK PARISH[1]

(*See* Figure 7)

The bog is about 2 miles southwest of Burnt Church wharf or village and about 27 miles northeast of Newcastle. It has an area of about 827 acres. Of this area:

	Cubic yards
85 acres have a depth of less than 5 feet, with an average depth of about 5 feet, and contain	686,000
292 acres have a depth of between 5 and 10 feet, with an average depth of 7 feet, and contain	3,298,000
264 acres have a depth of between 10 and 15 feet, with an average depth of 12 feet, and contain	5,111,000
181 acres have a depth of between 15 and 20 feet, with an average depth of 17 feet, and contain	4,964,000
5 acres have a depth of more than 20 feet, with an average depth of 21 feet, and contain	181,000

[1] All figures in this report are approximate. A ton is considered as 2,000 pounds; a cubic yard of drained bog is assumed to be equal to 120 pounds of dry peat litter.

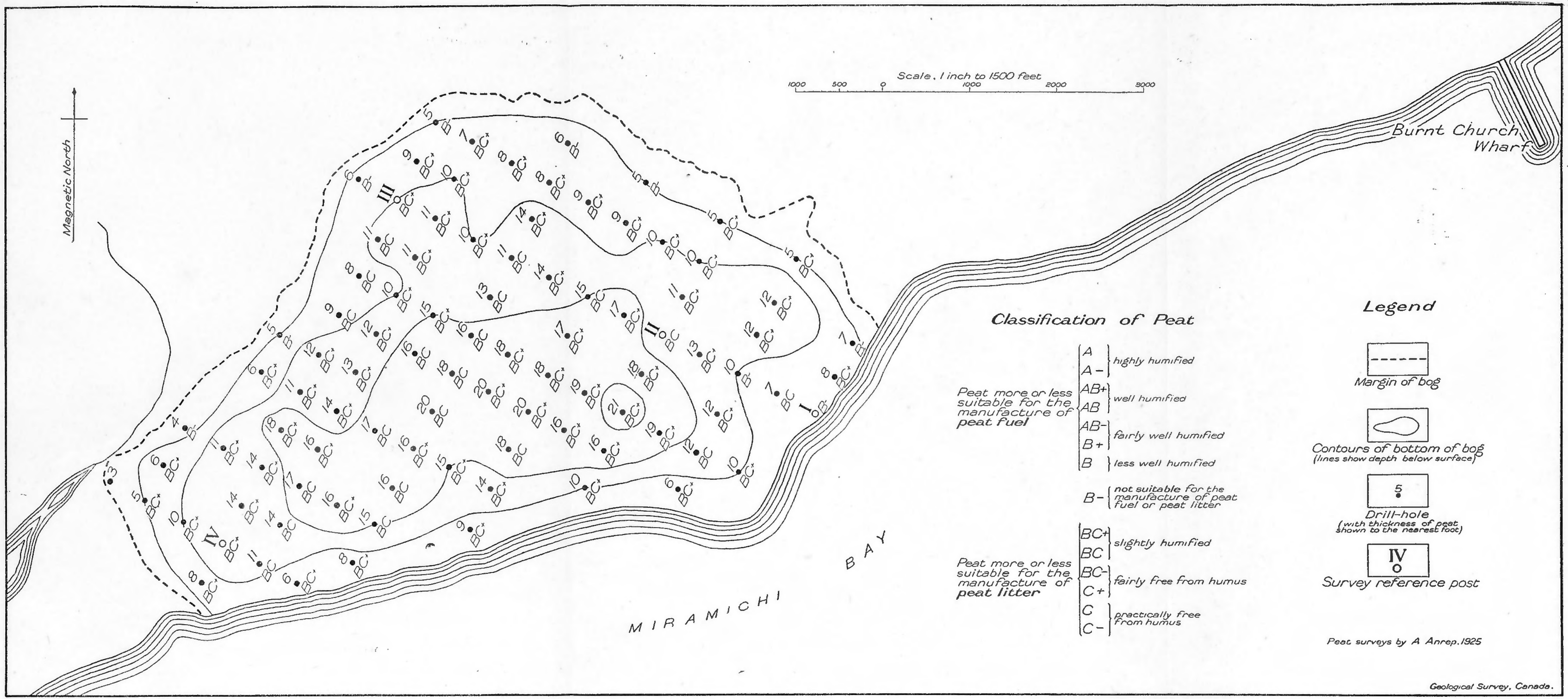

Figure 7. Burnt Church peat litter bog, Alnwick parish, Northumberland county, New Brunswick.

Excluding the acreage underlain by peat 5 feet or less in depth as not being of value commercially and allowing 2 feet shrinkage in depth after draining, there is available:

	Cubic yards
292 acres with an average depth of 5 feet, containing	2,355,000
264 acres with an average depth of 10 feet, containing	4,260,000
181 acres with an average depth of 15 feet, containing	4,380,000
5 acres with an average depth of 19 feet, containing	153,000

The total volume is 11,148,000 cubic yards of peat litter. The total tonnage is 669,000 tons or 846,000 tons of peat litter having 20 per cent moisture.

Partial Analyses of Samples

—	Samples from depths of		
	0–3 feet	3–6 feet	6–9 feet
	%	%	%
Sample No. 1			
Absorption factors for moisture-free peat	15·0	13·6	15·6
Absorption factor for peat with 20 per cent moisture	11·0	10·0	11·5
Ash (dried at 105° C.)	1·9	2·5	1·9
Sample No. 2			
Absorption factors for moisture-free peat	14·2	16·7	14·4
Absorption factor for peat with 20 per cent moisture	10·5	12·3	10·5
Ash (dried at 105° C.)	4·4	3·7	2·1
Sample No. 3			
Absorption factors for moisture-free peat	16·2	14·8	15·4
Absorption factor for peat with 20 per cent moisture	11·9	10·8	11·3
Ash (dried at 105° C.)	4·2	3·0	8·6

This bog is a typical high moor, as it swells from the surface of the ground in various places into domes reaching to a considerable height. The peat is slightly humified and will produce good peat litter. The upper layers are comparatively free from humus, hence a first-class litter may be obtained therefrom. The peat is formed of various sphagnum mosses, principally *Sphagnum fuscum* (Seh.), *Sphagnum capillaceum* (Weiss), and *Sphagnum tenellum* (Sehimp), slightly intermixed with *Scirpus hudsonianus,* eriophorum, and carex plants, which are more noticeable towards the margins of the bog. While drilling, it was found that the bottom layers were composed of carex, eriophorum, and aquatic plants, and also that the peat was free from roots and stumps.

The east side of the bog faces Imner bay at the mouth of Miramichi river, and is being eroded by wave and current action. The base of the bog and the underlying materials are distinctly visible along the shore of the bay. Immediately beneath the peat is a thin, discontinuous layer of bluish clay, resting on a thin layer of reddish clay, whose colour is due to limonite. These layers of clay rest upon a thick bed of boulder clay in which boulders of red sandstone and white limestone predominate and quartzite occurs in considerable quantity.

As the eastern side of the bog faces the mouth of Miramichi river it can easily be drained in that direction.

TABUSINTAC (NEGUAC) PEAT LITTER BOG, ALNWICK PARISH

(*See* Figure 8)

The bog lies about 1½ miles south of Tabusintac village, 5 miles east of Neguac, and 18 miles south of Tracadie. It has an area of about 3,868 acres. Of this area:

	Cubic yards
585 acres have a depth of less than 5 feet, with an average depth of 4 feet, and contain	3,775,000
815 acres have a depth of between 5 and 10 feet, with an average depth of 8 feet, and contain	10,519,000
1,281 acres have a depth of between 10 and 15 feet, with an average depth of 12 feet, and contain	24,800,000
725 acres have a depth of between 15 and 20 feet, with an average depth of 17 feet, and contain	19,884,000
310 acres have a depth of between 20 and 25 feet, with an average depth of 22 feet, and contain	11,003,000
128 acres have a depth of between 25 and 30 feet, with an average depth of 27 feet, and contain	5,576,000
24 acres have a depth of more than 30 feet, with an average depth of 31 feet, and contain	1,200,000

Excluding the acreage underlain by peat 5 feet or less in depth as not being of value commercially and allowing 2 feet shrinkage in depth after draining, there is available:

	Cubic yards
815 acres with an average depth of 6 feet, containing	7,889,000
1,281 acres with an average depth of 10 feet, containing	20,667,000
725 acres with an average depth of 15 feet, containing	17,545,000
310 acres with an average depth of 20 feet, containing	10,003,000
128 acres with an average depth of 25 feet, containing	5,161,000
24 acres with an average depth of 29 feet, containing	1,123,000

The total volume is 62,388,000 cubic yards of peat litter. The total tonnage is 3,748,000 tons or 4,685,000 tons having 20 per cent moisture.

Partial Analyses of Samples

—	Samples from depths of		
	0–3 feet	3–6 feet	6–9 feet
	%	%	%
Sample No. 1			
Absorption factors for moisture-free peat	15·7	14·7	10·2
Absorption factor for peat with 20 per cent moisture	11·5	10·8	7·4
Ash (dried at 105° C.)	1·8	3·0	1·9
Sample No. 2			
Absorption factors for moisture-free peat	17·7	13·0	2·0
Absorption factor for peat with 20 per cent moisture	14·7	10·8	1·9
Ash (dried at 105°C.)	11·4	8·3	2·2
Sample No. 3			
Absorption factors for moisture-free peat	16·5	12·1	1·9
Absorption factor for peat with 20 per cent moisture	15·7	11·5	1·8
Ash (dried at 105° C.)	14·9	10·9	1·8

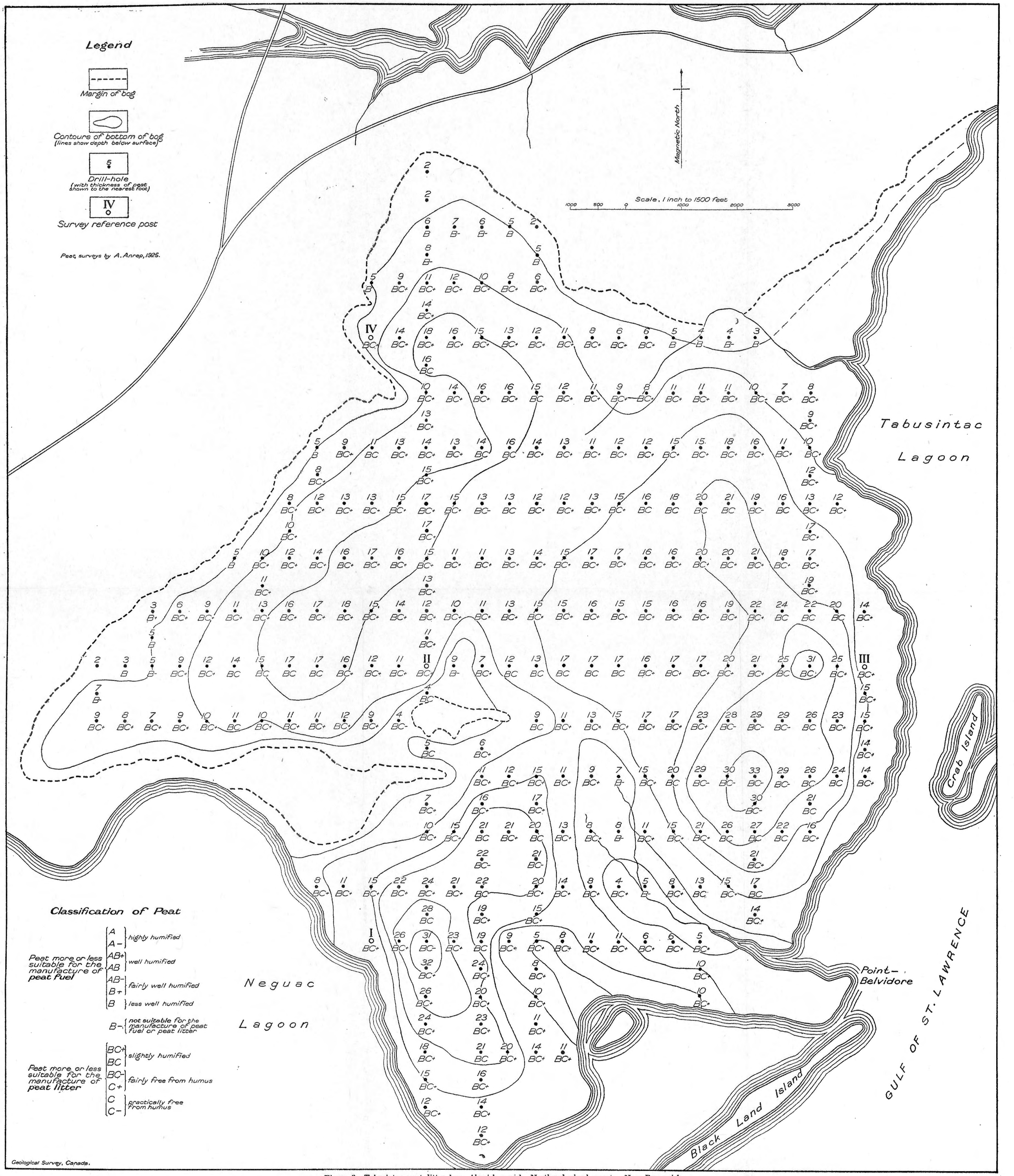

Figure 8. Tabusintac peat litter bog, Alnwick parish, Northumberland county, New Brunswick.

This is a high moor bog and swells in various places towards the centre into large domes. The peat is not humified and will produce good peat litter. The upper layers are comparatively free from humus, hence a first-class litter may be obtained therefrom. The peat is formed of various sphagnum mosses, principally *Sphagnum fuscum,* very slightly intermixed with eriophorum. While drilling, it was found that even the bottom layers were principally formed of sphagnum mosses intermixed with carex and eriophorum plants and also that the peat was free from roots and stumps. The bottom of the bog, from the sound of the drill, seems to be composed of boulder clay and sand.

The bog is situated on a peninsula and can easily be drained either into the Tabusintac or Neguac lagoons. Because of the quality and quantity of peat, and the favourable situation as regards shipping facilities, the bog is most suitable for the manufacture of peat litter on a commercial scale.

BLACK POINT PEAT LITTER BOG, ALNWICK PARISH

(*See* Figure 9)

The bog lies about 12 miles south of Tracadie. It has an area of about 497 acres. Of this area:

	Cubic yards
113 acres have a depth of less than 5 feet, with an average depth of 3 feet, and contain..........	547,000
104 acres have a depth of between 5 and 10 feet, with an average depth of 7 feet, and contain..........	1,175,000
104 acres have a depth of between 10 and 15 feet, with an average depth of 12 feet, and contain..........	4,375,000
54 acres have a depth of over 15 feet, with an average depth of 16 feet, and contain..........	1,393,000

Excluding the acreage underlain by peat 5 feet or less in depth as not being of value commercially and allowing 2 feet shrinkage in depth after draining, there is available:

	Cubic yards
104 acres with an average depth of 5 feet, containing..........	837,000
226 acres with an average depth of 10 feet, containing..........	3,646,000
54 acres with an average depth of 14 feet, containing..........	1,216,000

The total volume is 5,699,000 cubic yards with a total tonnage of 342,000 tons or 427,000 tons having 20 per cent moisture.

Partial Analyses of Samples

—	Samples from depths				
	0–3 feet	3–6 feet	6–9 feet	9–12 feet	12–16 feet
	%	%	%	%	%
Absorption factors for moisture-free peat....	14·0	16·0	12·4	14·0	8·5
Absorption factor for peat with 20 per cent moisture..........	10·2	11·7	9·0	10·2	6·1
Ash (dried at 105° C.)..........	1·7	1·9	2·2	2·1	1·7

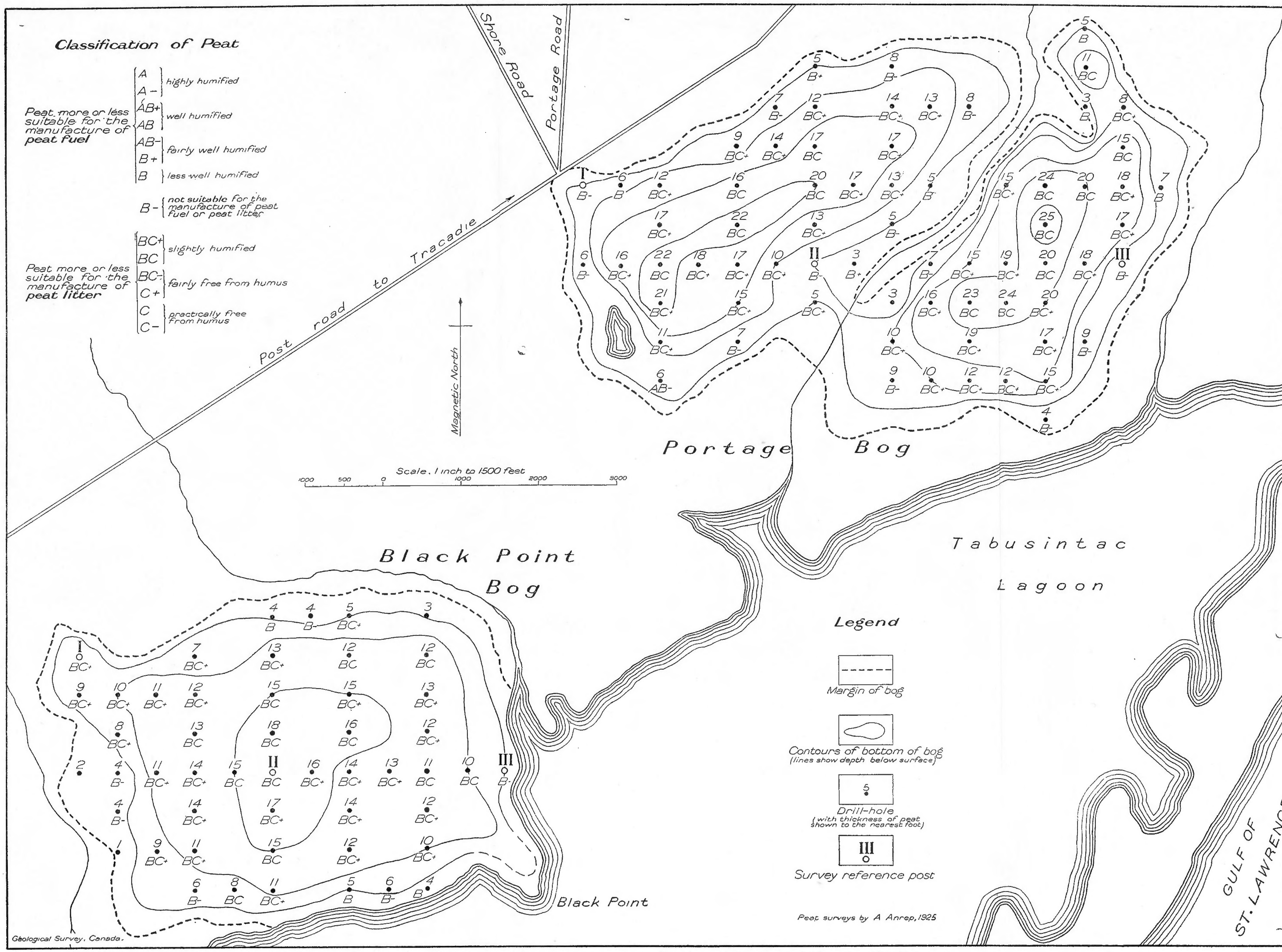

Figure 9. Black Point and Portage peat litter bogs, Alnwick parish, Northumberland county, New Brunswick.

The bog has a considerable depth. The surface is very irregular; it is a typical high moor, as it swells from the surface of the ground in various places into domes reaching to a considerable height. The peat is fairly free from humus and is composed mainly of sphagnum mosses which towards the southwestern margin are intermixed with carex and eriophorum plants. It can be easily drained either towards the eastern or southern side of the bog, as both of these sides are facing Tabusintac lagoon.

PORTAGE PEAT LITTER BOG, ALNWICK PARISH

(*See* Figure 9)

The bog is situated about 10 miles south of Tracadie village or 4 miles south of Tracadie river. It has an area of about 654 acres. Of this area:

	Cubic yards
148 acres have a depth of less than 5 feet, with an average depth of 4 feet, and contain	955,000
194 acres have a depth of between 5 and 10 feet, with an average depth of 7 feet, and contain	2,191,000
129 acres have a depth of between 10 and 15 feet, with an average depth of 12 feet, and contain	2,497,000
114 acres have a depth of between 15 and 20 feet, with an average depth of 17 feet, and contain	3,127,000
65 acres have a depth of between 20 and 25 feet, with an average depth of 21 feet, and contain	2,202,000
4 acres have a depth of more than 25 feet, and contain	161,000

Excluding the acreage underlain by peat 5 feet or less in depth as not being of value commercially, and allowing 2 feet shrinkage in depth after draining, there is available:

	Cubic yards
194 acres with an average depth of 5 feet, containing	1,565,000
129 acres with an average depth of 10 feet, containing	2,081,000
114 acres with an average depth of 15 feet, containing	2,759,000
65 acres with an average depth of 19 feet, containing	1,992,000
4 acres with an average depth of 23 feet, containing	148,000

The total volume is 8,545,000 cubic yards, with a total tonnage of 513,000 tons or 641,000 tons having 20 per cent moisture.

Partial Analyses of Samples

—	Samples from depths of				
	0–3 feet	3–6 feet	6–9 feet	9–12 feet	12–16 feet
	%	%	%	%	%
Absorption factors for moisture-free peat	17·6	17·1	20·0	13·5	12·8
Absorption factor for peat with 20 per cent moisture	12·9	12·6	14·7	9·9	9·3
Ash (dried at 105° C.)	3·0	1·9	2·3	2·1	1·7

The peat is fairly free from humus and has a considerable depth. This bog is a high moor characterized by several cupola-shaped hills. The depth and the profuse growth of sphagnum plants in these bogs are due to the even distribution of moisture throughout the year, resulting from the situation close to the coast where the even temperature and moist climate render the growth of the sphagnum mosses luxurious and rapid. The peat is composed mainly of sphagnum mosses slightly mixed with eriophorum. Towards the western and northern margins a great number of varieties of carex plants were found. On the whole it is suitable for the manufacture of peat litter. It is easily drained into Tabusintac lagoon.

TRACADIE BEACH PEAT LITTER BOG, SAUMAREZ PARISH

(*See* Figure 10)

The bog is about 5 miles southeast of the village of Tracadie. It has an area of about 245 acres. Of this area:

	Cubic yards
131 acres have a depth of less than 5 feet, with an average depth of 3 feet, and contain	634,000
39 acres have a depth between 5 and 10 feet, with an average depth of 7 feet, and contain	440,000
56 acres have a depth between 10 and 15 feet, with an average depth of 12 feet, and contain	1,084,000
19 acres have a depth of more than 15 feet, with an average depth of 16 feet, and contain	490,000

Excluding the acreage underlain by peat 5 feet or less in depth as being of no value commercially, and allowing 2 feet shrinkage in depth after draining, there is available:

	Cubic yard
39 acres with an average depth of 5 feet, containing	315,00
56 acres with an average depth of 10 feet, containing	903,000
19 acres with an average depth of 14 feet, containing	429,000

The total volume is 1,647,000 cubic yards with a total tonnage of 98,820 tons or 124,000 tons having 20 per cent moisture.

Partial Analyses of Samples

—	Samples from depths of		
	0–3 feet	3–6 feet	6–9 feet
	%	%	%
Absorption factors for moisture-free peat	13·2	15·9	11·5
Absorption factor for peat with 20 per cent moisture	9·6	11·7	8·4
Ash (dried at 105° C.)	3·0	2·1	3·8

This bog is a high moor characterized by one distinct cupola-shaped dome. The peat, except a narrow area close to the southeastern and northwestern margins, is slightly humified and will produce a fairly good litter, especially the upper layers which are free from humus. This bog is formed principally of sphagnum mosses. Eriophorum was found in some places towards the middle, but in greater quantities intermixed with carex plants towards the margins. It is suitable for the manufacture of peat litter, but only on a small scale on account of the small area of the bog. Drainage can be effected towards the south.

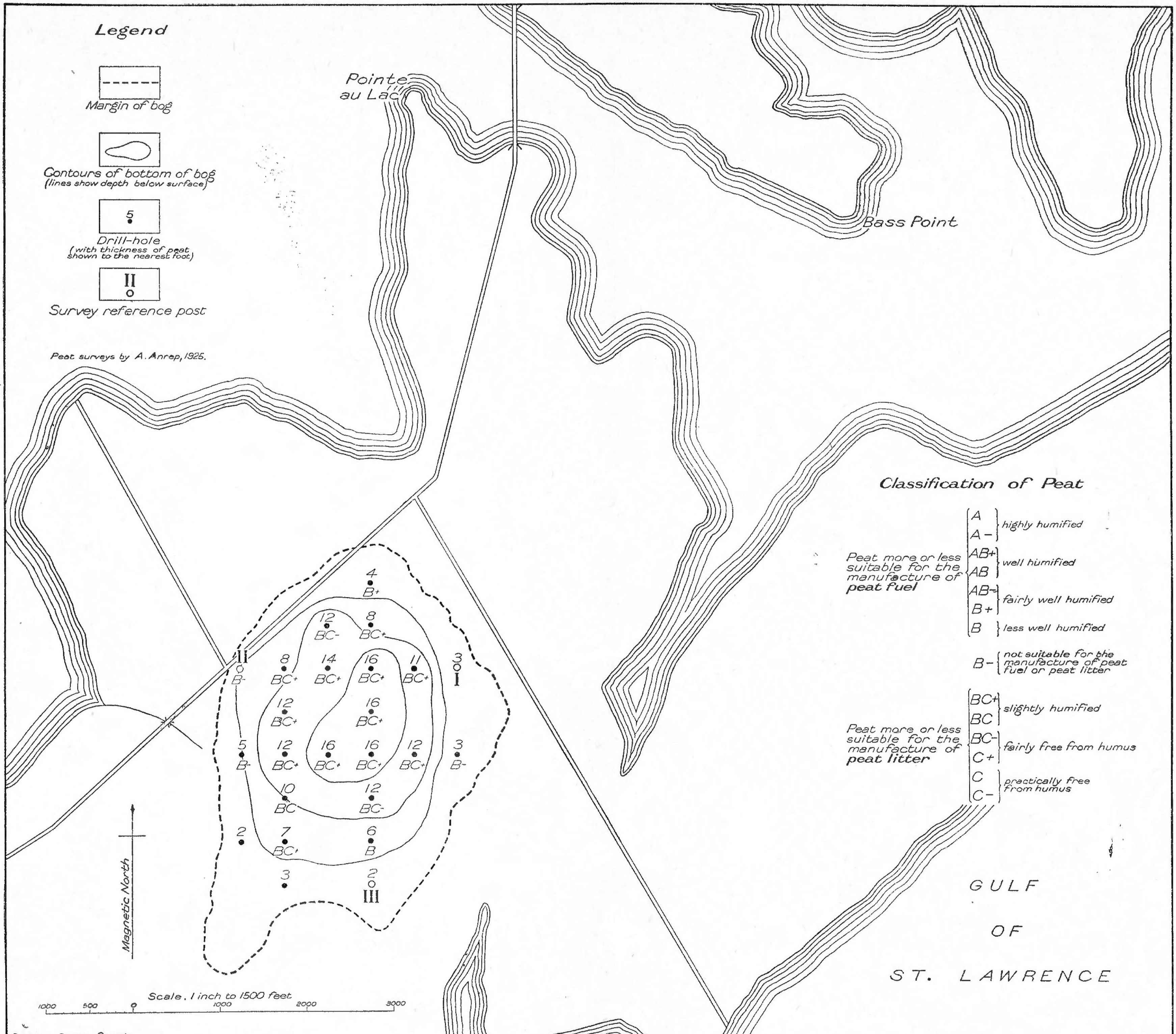

Figure 10. Tracadie Beach peat litter bog, Saumarez parish, Gloucester county, New Brunswick.

BOULLOU POINT PEAT LITTER BOG, SAUMAREZ PARISH

(*See* Figure 11)

This bog is about 2¼ miles south of Tracadie village. It has an area of about 205 acres. Of this area:

	Cubic yards
59 acres have a depth of less than 5 feet, with an average depth of 3 feet, and contain	286,000
60 acres have a depth of between 5 and 10 feet, with an average depth of 7 feet, and contain	678,000
47 acres have a depth of between 10 and 15 feet, with an average depth of 13 feet, and contain	986,000
39 acres have a depth of more than 15 feet, with an average depth of 17 feet, and contain	1,070,000

Excluding the acreage underlain by peat 5 feet or less in depth as not being of value commercially, and allowing 2 feet shrinkage in depth after drainage, there is available:

	Cubic yards
60 acres with an average depth of 5 feet, containing	484,000
47 acres with an average depth of 11 feet, containing	834,000
39 acres, with an average depth of 15 feet, containing	944,000

The total volume is 2,262,000 cubic yards, with a total tonnage of 136,000 tons or 170,000 tons having 20 per cent moisture.

Partial Analyses of Samples

—	Samples from depths of		
	0–3 feet	3–6 feet	6–9 feet
	%	%	%
Absorption factors for moisture-free peat	16·7	13·3	14·1
Absorption factor for peat with 20 per cent moisture	12·3	9·7	10·3
Ash (dried at 105° C.)	2·1	2·6	1·6

The peat is fairly free from humus and has a fair depth. This bog is a high moor, with many small knolls and dwarf trees. The bog could easily be drained in a southeast direction and being in close proximity to Tracadie village is suitable for the manufacture of peat litter on a commercial basis. The surface layers to a depth varying from 1 to 4 feet are composed mainly of sphagnum mosses practically free from humus and slightly intermixed with eriophorum and carex plants towards the margins. The bottom of this bog is of sand intermixed with grey clay.

LITTLE TRACADIE PEAT LITTER BOG, INKERMAN PARISH

(*See* Figure 12)

The bog is about 2 miles north of Tracadie village and immediately west of the post road. It has an area of about 240 acres. Of this area:

	Cubic yards
70 acres have a depth of less than 5 feet, with an average depth of 4 feet, and contain	452,000
60 acres have a depth of between 5 and 10 feet, with an average depth of 8 feet, and contain	771,000
40 acres have a depth of between 10 and 15 feet, with an average depth of 13 feet, and contain	839,000
58 acres have a depth of between 15 and 20 feet, with an average depth of 17 feet, and contain	1,591,000
12 acres have a depth of more than 20 feet, with an average depth of 21 feet, and contain	402,000

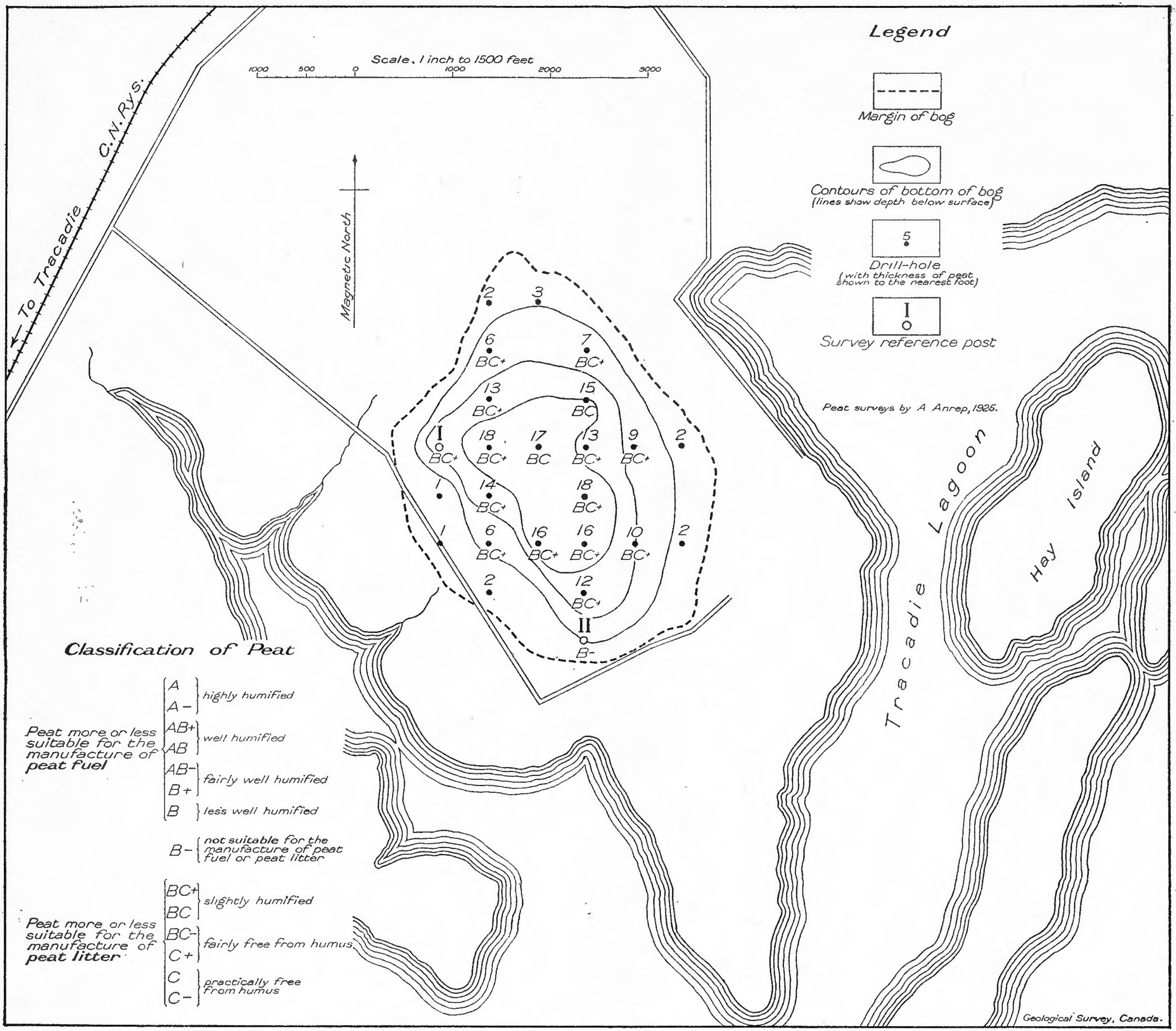

Figure 11. Boullou Point peat litter bog, Saumarez parish, Gloucester county, New Brunswick.

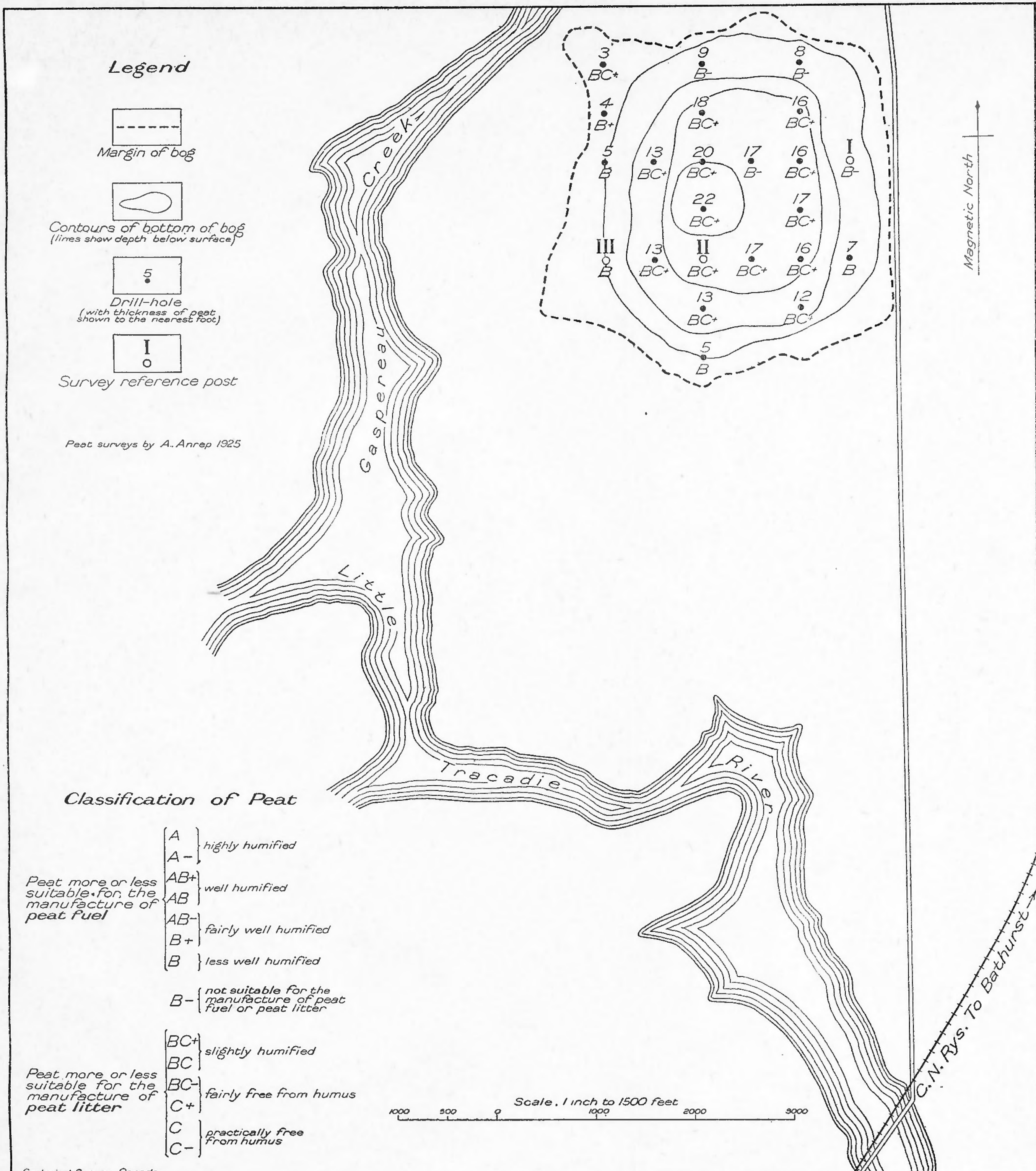

Figure 12. Little Tracadie peat litter bog, Inkerman parish, Gloucester county, New Brunswick.

Excluding the acreage underlain by peat 5 feet or less in depth as not being of value commercially, and allowing 2 feet shrinkage in depth after drainage, there is available:

	Cubic yards
60 acres with an average depth of 6 feet, containing	581,000
40 acres with an average depth of 11 feet, containing	710,000
58 acres with an average depth of 15 feet, containing	1,404,000
12 acres with an average depth of 19 feet, containing	368,000

The total volume is 3,063,000 cubic yards, with a total tonnage of 189,000 tons or 236,000 tons having 20 per cent moisture.

Partial Analyses of Samples

—	Samples from depths of			
	0–3 feet	3–6 feet	6–9 feet	9–12 feet
	%	%	%	%
Absorption factors for moisture-free peat	7·0	15·6	13·4	9·6
Absorption factor for peat with 20 per cent moisture	5·0	11·5	9·8	6·9
Ash (dried at 105° C.)	2·2	1·8	1·7	1·8

This bog also is a high moor with two distinct cupola-shaped domes. The peat, except a narrow strip following the margin of the bog, is only slightly humified and will produce a fairly good litter, especially the upper layers, which are fairly free from humus. The peat is composed of various sphagnum mosses slightly intermixed with eriophorum and towards the margin with carex plants. The bog has a fairly good depth and the surface is comparatively free from knolls. This bog can easily be drained towards the post road and being close to Tracadie village and only a few hundred feet from the railway track is most suitable for the manufacture of peat litter on a commercial basis.

GASPEREAU PEAT LITTER BOG, INKERMAN PARISH

(*See* Figure 13)

This bog lies about 5 miles northeast of Tracadie village and half a mile southeast of the Canadian National railway. It has an area of about 690 acres. Of this area:

	Cubic yards
180 acres have a depth of less than 5 feet, with an average depth of 3 feet, and contain	871,000
243 acres have a depth of between 5 and 10 feet, with an average depth of 8 feet, and contain	3,136,000
153 acres have a depth of between 10 and 15 feet, with an average depth of 12 feet, and contain	2,962,000
92 acres have a depth of between 15 and 20 feet, with an average depth of 17 feet, and contain	2,523,000
22 acres have a depth of more than 20 feet, with an average depth of 20 feet, and contain	710,000

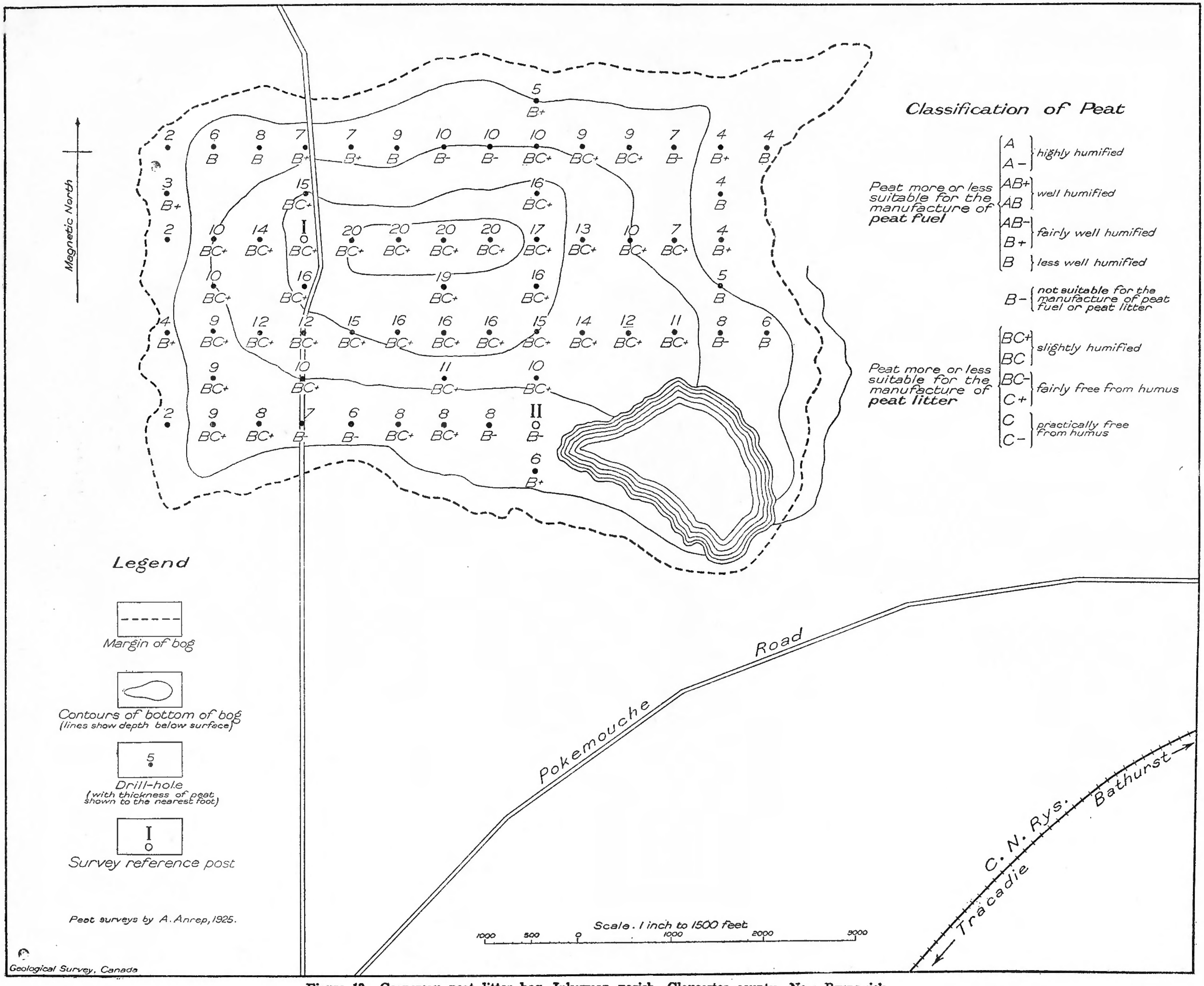

Figure 13. Gaspereau peat litter bog, Inkerman parish, Gloucester county, New Brunswick.

Excluding the acreage underlain by peat 5 feet or less in depth as not being of value commercially, and allowing 2 feet shrinkage in depth after drainage, there is available:

	Cubic yards
243 acres with an average depth of 6 feet, containing	2,352,000
153 acres with an average depth of 10 feet, containing	2,468,000
92 acres with an average depth of 15 feet, containing	2,226,000
22 acres with an average depth of 18 feet, containing	639,000

The total volume is 7,685,000 cubic yards, with a total tonnage of 461,000 tons or 576,000 tons having 20 per cent moisture.

Partial Analyses of Samples

—	Samples from depths of			
	0–3 feet	3–6 feet	6–9 feet	9–12 feet
	%	%	%	%
Absorption factors for moisture-free peat	10·7	8·2	9·4	8·7
Absorption factor for peat with 20 per cent moisture	7·8	5·9	6·8	6·3
Ash (dried at 105° C.)	2·3	2·2	1·4	1·5

The peat in this bog is more or less humified and the southeastern part, towards the lake, is so much so that it is not suitable either for peat litter or peat fuel. The upper layers of the bog towards the centre are fairly free from humus, but become more humified towards the bottom, nevertheless it will produce a fairly good peat litter. The bog is a high moor characterized by one distinct cupola-shaped hill. The peat is composed of various sphagnum mosses slightly intermixed with eriophorum and towards the margin with carex plants. The bog has a good depth and the surface is comparatively free from knolls, as fires have swept the surface of the bog several times. Charred trees are left in groups on the bog, making the clearing of the surface more difficult. This bog can easily be drained in a southerly direction towards the lake.

GREEN POINT PEAT LITTER BOG, INKERMAN PARISH

(*See* Figure 14)

This bog is about 9 miles north of Tracadie village and 1½ miles south of Inkerman station, Canadian National railway. It has an area of about 1,516 acres. Of this area:

	Cubic yards
205 acres have a depth of less than 5 feet, with an average depth of 3 feet, and contain	992,000
373 acres have a depth of between 5 and 10 feet, with an average depth of 7 feet, and contain	4,212,000
500 acres have a depth of between 10 and 15 feet, with an average depth of 12 feet, and contain	9,680,000
363 acres have a depth of between 15 and 20 feet, with an average depth of 17 feet, and contain	9,956,000
75 acres have a depth of more than 20 feet, with an average depth of 21 feet, and contain	2,541,000

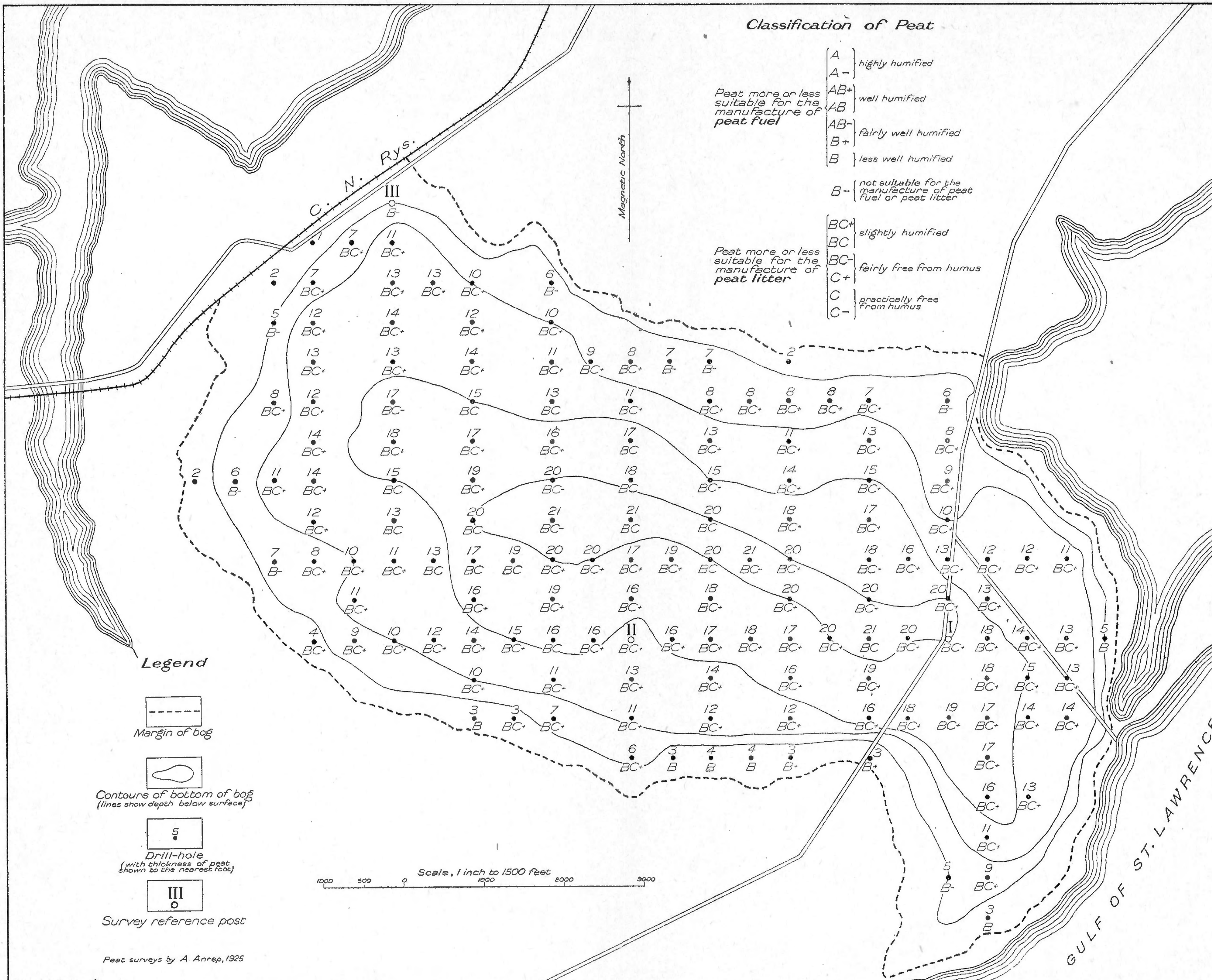

Figure 14. Green Point peat litter bog, Inkerman parish, Gloucester county, New Brunswick.

Excluding the acreage underlain by peat 5 feet or less in depth as not being of value commercially, and allowing 2 feet shrinkage in depth after drainage, there is available:

	Cubic yards
373 acres with an average depth of 5 feet, containing	3,009,000
500 acres with an average depth of 10 feet, containing	8,067,000
363 acres with an average depth of 15 feet, containing	8,785,000
75 acres with an average depth of 19 feet, containing	2,299,000

The total volume is 22,160,000 cubic yards, with a total tonnage of 1,330,000 tons or 1,663,000 tons having 20 per cent moisture.

Partial Analyses of Samples

—	Samples from depths of				
	0–3 feet	3–6 feet	6–9 feet	9–12 feet	12–16 feet
	%	%	%	%	%
Sample No. 1					
Absorption factors for moisture-free peat	16·5	14·0	14·4	16·5	15·2
Absorption factor for peat with 20 per cent moisture	12·1	10·3	10·6	12·1	11·1
Ash (dried at 105° C.)	2·1	2·9	1·9	1·7	2·3
Sample No. 2					
Absorption factors for moisture-free peat	16·1	16·3	17·7	14·1	13·7
Absorption factor for peat with 20 per cent moisture	11·8	12·0	13·0	10·3	10·0
Ash (dried at 105° C.)	1·7	1·9	1·7	1·7	2·4

The peat in this bog towards the centre is fairly free from humus, but towards the margin becomes more humified, especially the shallow part of the bog immediately south of the Canadian National railway, which is neither suitable for peat litter nor peat fuel. The upper layers of the bog towards the centre are practically free from humus and hence would produce a good peat litter. The bog is a high moor characterized by several distinct cupola-shaped hills, especially noticeable in the part of the bog east of the road and facing the coast. The peat is composed of various sphagnum mosses slightly intermixed with scirpus, eriophorum, and carex grasses. Towards the margins the carex grasses, eriophorum, and other vegetation like blueberry bushes, ferns, hypnum mosses, and other plants are more prevalent. The bog has a good depth and the surface is comparatively free from knolls and trees. The bog can easily be drained towards the gulf of St. Lawrence. This bog being favourably located as regards water and rail, is very suitable for the manufacture of peat litter on a large commercial basis.

While this and the Gaspereau bog were being investigated, hundreds of wagon loads of raw peat were being dug and carted away to be applied on the land or used for compost. It is a mistake to apply raw, sour peat with 90 per cent moisture to the land or to use it immediately for the preparation of compost, as the peat in that state is entirely void of nitrogen and contains no plant food. The peat ought first to be dried until the moisture content is 20 per cent, then used as an absorber of animal spillings, and afterwards applied to the land. It is apparent, however, that farmers are beginning to realize the great value of the peat lying almost at their front doors.

VARIOUS USES OF PEAT[1]

Peat in general may be used for a variety of purposes, but since peat varies in character it is essential that a deposit should be carefully examined with regard to its suitability for any proposed purpose, such as the production of fertilizers, stable litter, a basis for stock foods, as a packing material, as an absorbent and deodorant, as a filler for manufacturing cardboard or coarse paper, and the manufacturing of peat fuel.

Peat is composed of the remains of plants of various species and in varying stages of decomposition, thus giving rise to different kinds of peat. It may be practically undecomposed, that is, free from humus, and be formed mainly of different mosses. It may be slightly humified, coarsely fibrous matter containing plainly recognizable roots, rhizomes, and aerial parts of plants. Or it may be well humified and compact, with its fibrous constituents decomposed and the greater part of it consisting of disintegrating leaves and woody parts of trees and shrubs. These physical differences accompany marked differences in chemical and mechanical properties.

Nearly all raw peat is more or less acid, contains very little bacterial life, and most of its nitrogen content is not available to plant life. Therefore, raw peat, especially if formed of sphagnum mosses not humified, cannot without further treatment be successfully used as a fertilizer. But such peat may be treated in several ways to produce a fertilizer of a high grade, and of great value when applied to soils deficient in organic matter and nitrogen. Peat that is formed principally of sphagnum mosses and is fairly free from humus is highly absorbent and, therefore, pre-eminently suitable for the manufacture of peat litter and peat mull. The higher humified, more compact peats are more suitable for the manufacture of fuels, and the quality of the fuel depends mainly upon the degree of humification. Peats which are neither free from humus nor well humified are not suitable either for litter or fuel, but are more susceptible to bacterial inoculation and seem to change into fertilizers much quicker than the less humified sphagnum moss peats that are so suitable for use as peat litter. It is interesting to note that the peat bogs of southern Ontario and Quebec are, in a general way suitable for fuel purposes, whereas the extensive bogs of New Brunswick and Nova Scotia and those of Quebec, along the northern shores of the lower St. Lawrence, are potential sources for the manufacture of peat litter and, on the other hand, the enormous peat bogs of western Ontario and of Manitoba, though neither suitable for the manufacture of peat fuel nor peat litter, will eventually be of value for bacterial inoculation and, consequently, as a source of fertilizer. It thus appears that the peat suitable for fuel is adjacent to the industrial centres and the other varieties occur in areas where it can be employed as a fertilizer.

PEAT LITTER

Peat suitable for litter is mainly formed of sphagnum mosses but little humified. It should be dug in the autumn and left exposed to the

[1] *See* "Peat, Its Manufacture and Uses"; Mines Branch, Dept. of Mines, Canada (1926).

frost during the winter, whereby it is rendered more porous and more susceptible to decomposition when mixed with stable manure. It should then be dried by exposure to the sun and air, disintegrated by mechanical device, screened, and baled. The manufactured product is most commonly used as bedding for domestic animals, except sheep, and, subsequently, as a fertilizer, as it absorbs the liquid manure. Some masses absorb as high as twenty-eight times their own weight in moisture.

"A simple method (for the preparation of peat litter) is frequently employed by farmers to prepare comparatively small quantities of litter for use on their own farms. A part of the bog, sufficiently drained to allow the use of horses on its surface, is ploughed to a depth of 6 or 8 inches in the autumn. The following spring the peat is thoroughly harrowed, and when sufficiently air-dried, is scraped into heaps, conveyed to a storehouse and used as required. The surface can be harrowed several times during the summer, as the peat, spread out in a thin loose layer, is quickly dried by the wind and sun."[1]

Peat litter is specially well adapted for use in stables, pig or hen houses. One ton of a good peat moss litter will last as bedding as long as 2½ tons of straw. A properly laid and looked after bedding of peat litter can last for over two months. No disagreeable odour arises from it. It is highly conducive to healthy growth of the hoof and cures a bad case of trush. The animals are kept cleaner and healthier with a quarter less labour than when straw is used. When peat moss bedding is used and properly handled very few or no flies are found. It is also perfectly free from danger of fire, as it is less combustible than straw. No drainage of the stalls is needed except a cement floor. . . . .

"By absorbing the liquid manure the most valuable portion is saved since it (the liquid part) contains ordinarily, over half of the nitrogen and four-fifths of the potash of the total manure. . . . Peat litter also adds considerable fertilizing value to the manure in the form of nitrogen compounds and organic matter."[2]. . . . . .
Furthermore, it is claimed that the addition of peat litter improves in various ways the quality of the soil.

PEAT MULL

Peat mull, a powdery form of peat obtained when shredded peat is screened during the process of manufacture of peat litter, is used as a packing material, an insulator, as an absorbent and deodorant, and a basis for foods for live stock.

Peat mull has long been used for the preparation of food for stock, by mixing it with refuse molasses, obtainable in large quantities at a comparatively low price from beet sugar factories and cane-sugar refineries. The refuse molasses is an excellent and fattening food when mixed in proper proportions with peat mull. "The corrective qualities of peat make it a desirable material also for mixture with cotton seed meal."[3]

"The absorbent and deodorant, as well as to some extent disinfectant, properties of peat mull (peat dust) make it a very desirable material for use in earth closets, cess pools, etc. In places where there is no public water supply or sewage disposal system, its use for this purpose would be in the interest of public health."[4]

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1 *See* "Peat Its Manufacture and, Uses"; Mines Branch, Dept. of Mines Canada (1926).
2 Op. cit., p. 242.
3 Op. cit., p. 243.
4 Op. cit., p. 243.

DEEP BORINGS IN ONTARIO, QUEBEC, AND THE MARITIME PROVINCES[1]

By E. D. Ingall

The Borings Division exists for the purpose of accumulating and studying records of borings made in any part of Canada, so that the information gained may be available for the guidance of drill operators and others.

An essential feature of the work consists in an exact study of samples of the strata passed through by bore-holes. In order that such samples may be as accurately representative of the strata penetrated as the drilling methods permit, it is most important that *the samples be sent direct without previous washing or other preparatory operations.* Samples should be taken at short intervals because unsuspected but important variations may exist in material appearing to be homogeneous.

As in the past few years the work of the Borings Division in Ontario has been prosecuted largely in co-operation with Colonel R. B. Harkness, Commissioner of Gas, Provincial Government. Through him have been received, during the year, some one hundred and seventy-two logs from the records in his office in Toronto. These were mostly of borings made in the western peninsula of Ontario between 1923 and 1925 and represent records demanded of the operators under the authority of the Ontario law which created the office of Commissioner of Gas. Except in a few cases, the descriptions of the strata passed through were furnished by the drillers. In addition there were received through the Commissioner of Gas some sets of samples from the various wells in the tabulation given below.

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[1] Information regarding boring records for British Columbia and the Yukon, the Prairie Provinces, etc., will be found in Parts A and B of the Geological Survey Summary Reports.

Records Received from the Province of Ontario

Location				Description			
Lot	Township	Concession, tract, or road	County	Year made	Total depth in feet	—	—
4	Rainham	V	Haldimand	1925	895	Gas	Dominion Natural Gas Co.
17	Walpole	VI	"	1925	930	Dry	" "
16	"	VII	"	1925	939	Gas	" "
16	"	VII	"	1925	896	"	" "
4	Rainham	V	"				" "
W ½ 15	Moulton	4, S.F.R.	"	1924	693		United Gas Companies, Ltd.
E ½ 16	"	S.F.R.	"	1924	723	Gas	" "
E ½ 16	"	"	"	1925	717	"	" "
4	Cayuga N.	Huff tract	"	1924	742	Dry	Dominion Natural Gas Co.
6	"	Jones tract	"	1924	780	Gas	" "
6	"	"	"	1924	722	"	" "
N ½ 17	Seneca	III	"	1924	595	"	Hoover and May
	"	Nelles tract	"	1924	585	"	" "
1	"	III	"	1924	587	"	" "
E ½ 4	"	Nelles tract	"	1924	643	"	Dominion Natural Gas Co.
W ½ 5	"	"	"	1925	633	"	" "
W ½ 2	"	N ½ II	"	1924	575	"	Canboro' Gas and Oil
14	Moulton	N.F.R.	"	1924	667	Dry	United Gas Companies, Ltd.
13	"	S.F.R.	"	1924	707	Gas	" "
13	"	"	"	1925	680	Dry	Dominion Natural Gas Co.
1	Canborough		"	1924	684	Gas	Darling Road Gas and Oil Syndicate
N ½ 2	"	II	"	1924			Canboro' Gas and Oil Co.
13	"	III	"	1924	685	Gas	Darling Road Gas and Oil Syndicate
17	Moulton	N.F.R.	"	1924	680	"	United Gas Companies, Ltd.
23	Oneida	III	"	1924–25	794	Dry	Dominion Natural Gas Co.
24	"	III	"	1924	800	Gas	" "
24	"	III	"	1924	766	Dry	" "
N ½ 16	Seneca	III	"	1924	580	Gas	Hoover and May
	"	Nelles tract	"		594	"	Dominion Natural Gas Co.
2–3	Cayuga N.	Huff tract	"	1924	731	"	" "
384	"	"	"	1924	741	"	" "
16	Moulton	I	"	1924	666		Allied Gas and Oil Co.
16	Sherbrooke	I	"	1919	982		Sterling Gas Co.
3	Walpole	VIII	"	1924	991	Gas	Dominion Natural Gas Co.
8	"	IV	"	1924	989	"	" "
8	Seneca	3 Nelles tract	"	1924	585	"	Port Colborne–Welland Gas Co.
2	Rainham	IX	"	1925	1,334	"	Nelles Corners Gas Syndicate
9	Moulton	IV Cross	"	1925	722	"	United Gas Companies, Ltd.
12	"	S.F.R.	"	1925	687		" "
13	"	"	"	1924–25	680		" "

Records Received from the Province of Ontario—Con.

Location				Description			—
Lot	Township	Concession, tract, or road	County	Year made	Total depth in feet	—	
9-12-13	Moulton........	IV............	Haldimand	1925......	737	Gas......	United Gas Companies, Ltd.
15A	"	IV Cross.......	"	1925......	689	"	" "
8	Cayuga S.......	IV............	"	1925......	842	"	W. E. Patterson
6	Rainham.......	VI............	"	....	....	....	Hoover and May
6	"	V............	"	1925......	915	"	Lake Erie Oil and Gas
2	"	IX............	"	1925......	859	Dry......	W. C. Patterson
2	"	VIII...........	"	1925......	864	Gas......	Dominion Natural Gas Co.
7	Cayuga S.......	IV............	"	1925......	842	Gas......	W. C. Patterson
12	Seneca.........	III............	"	1925......	553	....	Hoover and May
NW ¼ 12	"	III............	"	....	....	....	
4	Rainham.......	V............	"	1924–25...	900	Gas......	Erie Gas and Oil Syndicate
12	Walpole.........	VI............	"	1924–25...	940	....	Dominion Natural Gas Co.
NW ¼ 19	"	VII............	"	1924......	924	Gas......	" "
S ½ 18	"	VIII...........	"	1924......	900	"	" "
River rge..	Seneca.........	Nelles tract.....	"	1924......	635	"	" "
W ½ 5	"	"	"	1923......	614	"	" "
9	"	"	"	1924......	603	"	Hoover and May
	"	"	"	1924......	635	"	Dominion Natural Gas Co.
E ½ 5	"	"	"	1924......	614	"	" "
	"	"	"	1924......	629	"	" "
NW ½ 18	Walpole.........	VII............	"	1924......	917	"	" "
N ½ 7	"	III............	"	1924......	985	"	" "
W ½ 4	"	IV............	"	1924......	990	Dry......	" "
22	"	III............	"	1925......	923	Gas......	" "
7	Cayuga N.......	III............	"	1925......	772	"	" "
3	Rainham.......	IV–V..........	"	1925......	932	"	" "
12	Moulton........	II............	"	1925......	762	"	United Gas Companies, Ltd.
23	Oneida.........	III............	"	1924–25...	794	Dry......	Dominion Natural Gas Co.
6	Cayuga N.......	III............	"	1925......	747	Gas......	" "
5–7	Cayuga N.......	I south.........	"	1925......	896	"	Nelles Corners Gas Syndicate
1	Rainham.......	VIII...........	"	1925......	871	Dry	Dominion Natural Gas Co.
15	Walpole.........	VII............	"	1925......	930	Gas......	" "
15–16	"	VIII...........	"	1925......	926	"	" "
8	Seneca.........	3 Nelles tract...	"	1923......	583	Gas......	Port Colborne-Welland Gas Co.
9	"	" ..	"	1923......	593	"	" " "
A	"	II............	"	1924......	541	Dry......	Canboro' Gas and Oil Co.
2	"	II............	"	1924......	575	Gas......	" "
2	"	II............	"	1924......	579	"	" "
NW ¼ 5	Walpole.........	IV............	"	....	....	....	Dominion Natural Gas Co.
3	"	IV............	"	1924......	915	"	" "
17	"	IV............	"	1924......	915	"	" "

	15	Moulton	4 S.F.R.	“	1924	712	“	United Gas Companies, Ltd.
	14	“	S.F.R.	“		687	“	“ “
NW ½	16	“	“	“	1924	718	“	“ “
	6	Cayuga N.	Jones tract	“	1924	768	“	Dominion Natural Gas Co.
	4	“	Huff tract	“	1924	742	Dry	“ “
	5	“	“	“	1924	735	“	“ “
	2	Seneca	II	“	1924	574	Gas	Canboro’ Gas and Oil Co.
	3	“	II	“	1924	581	“	“ “
	9–10	Walpole	III	“	1924	1,000	“	Dominion Natural Gas Co.
	18	“	VII	“	1924	914	“	“ “
NE ½	18	“	VII	“	1924	897	“	“ “
	15	Woodhouse	VI	Norfolk		975		“ “
Cen.½	16	Middleton	3 S. Talbot rd.	“				Medina Natural Gas Co.
N ½	16	“	2 “	“				“ “
	5	“	V	“	1924	425		Caledonia Oil and Gas Co.
	13	“	XI	“	1924	1,276	Gas	Dominion Natural Gas Co.
	16	“	XI S.	“		1,265	“	“ “
	15	“	II S.	“		1,351	“	“ “
	15–16	Townsend	XIV	“	1924–25	1,024	“	“ “
	14–15	Middleton	III	“	1925	1,275	“	“ “
	17	“	II	“	1925	1,308	“	“ “
SW ½	15	“	XI S. Talbot rd.	“				Medina Natural Gas Co.
	17	“	II	“				Dominion Natural Gas Co.
	17	Woodhouse	VI	“	1925	1,062	Dry	“ “
	17	Middleton	III	“	1925	1,374	Gas	“ “
	16	“	II S. Talbot rd.	“				Medina Natural Gas Co.
	16	“	III	“	1925	1,284	Gas	Dominion Natural Gas Co.
	16	“	III	“				“ “
	15–16	Townsend	XIV	“	1924–25	1,024	Gas	“ “
	18	Woodhouse	IV	“	1924	996	Dry	“ “
	6	“	IV	“	1924	1,086	Gas	“ “
	12	“	IV	“	1924	1,065	Dry	“ “
	24	Dunwich	5 north of A.	Elgin				Peace River Development Co.
	34	Malahide	II	“	1924	1,560	Dry	Dominion Natural Gas Co.
	25	“	II	“	1924	1,558	“	“ “
	14	Dunwich	XI	“	1924	310	“	Callahan and Browett
	17	Dover E.	VII	Kent		3,810		Eugene Coste Co. 682 samples received
	54	Tilbury E.	XVI	“	1924	1,353	Gas	Southern Ontario Gas Co.
		“	XVI	“	1924	1,407	Dry	“ “
	174	“	N. Talbot rd.	“	1924	3,770	Gas	Union Natural Gas Co.
	485	“	XVI	“	1924	1,407	Dry	Southern Ontario Gas Co.
		“	M.R.S.	“		1,354		“ “
	10	“	M.R.N.	“	1924	3,682	Dry	Union Natural Gas Co.
	184	Romney	Talbot rd.	“	1924	3,653	Gas	“ “
	133	“	“	“	1924	1,374	“	Southern Ontario Gas Co.
W ½	192	“	“	“	1924	1,365	“	“ “
	170	Tilbury E.	“	“	1924	1,323	“	Union Natural Gas Co.
	178	Romney	S. Talbot rd.	“	1924	1,380	Gas	Union Natural Gas Co.
	192	“	Talbot rd.	“	1924	1,372	“	Southern Ontario Gas Co.

Records Received from the Province of Ontario—Con.

Location				Description			
Lot	Township	Concession, tract, or road	County	Year made	Total depth in feet	—	—
E ½ 192	Romney	Talbot rd.	Kent	1924	1,365	Gas	Southern Ontario Gas Co.
Gore 5	Camden	XIII	“	1925	597	“	Ajax Oil and Gas Co.
1	Raleigh	A	“				Stack and Spencer
172	Tilbury E.	Talbot rd.	“	1925	1,350	Gas	Union Natural Gas Co.
S ½ 2	“	XV	“	1925	1,367	“	Southern Ontario Gas Co.
7	“	XV	“	1924	1,400	“	Union Natural Gas Co.
S ½ 3	“	XV	“	1924	1,370	“	Southern Ontario Gas Co.
19	“	VII	“	1924	3,575	Dry	Eugene Coste Co.
S ½ 2	“	XV	“	1925	1,357	Gas	Southern Ontario Gas Co.
184	Romney	Talbot rd.	“	1924	3,654	“	Union Natural Gas Co.
173	Tilbury E.	“	“	1925	1,334	“	“ “
186	Romney	“	“	1925			“ “
172	Tilbury E.	“	“				
5	Camden	XIII	“				Ajax Oil and Gas Co.
3	Dover W.	III	“				Union Natural Gas Co.
5	Camden S.	XIII	“	1924–25	597	Oil	Ajax Oil and Gas Co.
1	Tilbury E.	XV	“	1925	1,366	Gas	Southern Ontario Gas Co.
78	Colchester	I	Essex	1924	2,905		“ “
1	Gosfield S.	I	“	1924	953	Gas	B. Jasperson
E ½ 14	Adelaide	1, W.S.R.	Middlesex	1924	350		Alex Gardiner
7	Mosa	VII	“	1924	350		John Scott
18	“	II	“		317		Newberry Oil and Gas Syndicate
9-16-11	Onondaga	III	Brant	1925	585	Gas	
2	Oakland	I	“	1924	855	Dry	Dominion Natural Gas Co.
2	“	II	“	1924	852	“	“ “
2	“	I	“	1924	850	Gas	“ “
7	Onondaga	3 E.F.C.	“	1924	2,712		Canadian Dutch Oil Co.
7	“	III	“				“ “
	Sarnia		Lambton	1924–25	660		Sarnia City Dairy
10	“	III	“	1925	400	Gas	Reuben Proctor
13	“	XI	“	1924	480	“	W. Smith
11	“	II	“	1924	440	“	Walter Cox
N ½ 5	“	McGregor rd.	“	1924	518		J. L. Ritchie
22	Bosanquet	V	“	1924	390½	Dry	John Scott
3	Moore	XVI	“	1924	480	“	Duncan Bros.
10	Sarnia	III	“	1925	435	Gas	Wm. Beadle
Indian reserve	“	Scott st.	“	1924	548	“	
20	Logan		Perth				Mitchell Oil Producing Syndicate
17	Eastnor	4 W.B.R.	Bruce	1924	1,600		Mulberry Creek Oil Co.
	Madoc		Hastings	1925	45		John T. Hart, Sr. 6 samples received.
Pelee island			Essex	1924	815	Dry	E. L. Fee

Laboratory work on sets of samples from several wells has been commenced in order to determine the horizontal extension of the Whirlpool, Grimsby, and Clinton horizons. Detailed laboratory work was also done on the samples from the Coste No. 7 well, and chemical determinations of gypsum and anhydrite in various wells were made. Laboratory examinations were made of cores from borings in the vicinity of Cornwall.

In the early part of 1925 the Department of Railways and Canals applied for geological assistance in interpreting the results of their campaign of borings in the vicinity of Lachine, Quebec. Mr. Maddox, of the Borings Division staff, visited the field, and cores from the borings tabulated below having been received has examined and reported upon them.

Records Received from the Department of Railways and Canals

Locality and hole No.	Depth reached	Number of samples	Year made	Depth to first rock
Lachine—	Feet			Feet
23	78·5	6		
24	76	8		
25	69	9		
26	41	5		
27	35·2	6		
28	27·8	5		
29	48·5	2		
30				
Laprairie basin—				
31	19	2		
32	28	2		
33	28	4		
34	24	2		
35	27	3		
36	34·7	3		
1	30	4		
2	25	3		
3	35·6	2		
4	25·5	3		
5	24	1		
6	28·4	2		
7	29	3		
Lake St. Louis—				
1	62·6	3		
2	58·1	3		
3	53·3	2		
4	51·3	3		
5	62·6	4		
8	22·8	6		
11	12	2		
12	44·9	3		
13	18·5	2		
Verdun—				
1	52·5	5	1925	32·5
2	45·8	4	1925	27·0
3	44·5	7	1925	27·8
4	63·4	7	1925	23·6
5	....	3	1925	....
6	....	4	1925	....
7	....	6	1925	....
8	....	3	1925	....
9	....	3	1925	....
Lachine—				
19	72·3	5	1925	46·0
South of Allard st. on Monk boulevard—				
1	56·0	6	1925	20·0
South of Allard st. on Irwin ave.—				
2	34·7	5	1925	15·0
Ville Emard—				
3	60·7	6	1925	14·7
Dorval—				
2	50·1	6	1925	10·0

No records of deep borings for gas and oil in the Palæozoic basin of eastern Ontario and Quebec were recorded during 1925.

In eastern Ontario, the wedge of territory between the converging Ottawa and St. Lawrence rivers is underlain by a series of Palæozoic strata which yield indications of natural gas and petroleum over a wide range. This series is continuous in an easterly direction through the province of Quebec. It forms a narrow fringe north of the St. Lawrence as far as the city of Quebec and extends southerly in a practically undisturbed condition as far as the great Lake Champlain-St. Lawrence fault. This undisturbed zone of possible oil and gas-bearing strata between its western limit in eastern Ontario and its eastern limit in the vicinity of Quebec city, extends for a distance of about 250 miles, and has an average width of 50 miles. The stratigraphical succession is related to that of the peninsula of western Ontario, the Trenton group being common to both. In the west, however, the underlying Precambrian is encountered at the base of the Trenton, whereas in the eastern area, sediments of Lowville, Chazy, Beekmantown, and Potsdam age intervene between the lowest Trenton and the Precambrian.

Borings in Ottawa district indicate a thickness of about 1,375 feet from the top of the Trenton to the Precambrian. Upwards the series in this district practically terminates at the top of the Cincinnatian group, although at various places isolated areas of red, sandy shales are found, probably of Queenstown age. In the Ottawa-Montreal part of the area these patches of red beds are quite small and under 100 feet in thickness, whereas in the Eastern Townships of Quebec, where they occupy synclinal troughs, borings near St. Hyacinthe have shown as much as 1,000 feet. A marked feature of the sedimentary series is the great and rapid thickening of the Richmond, Lorraine, and Utica shales overlying the Trenton, in their extension southeast from Ottawa district. Thus, in St. Hyacinthe district, borings about 3,000 feet in depth did not reach the bottom of the Lorraine.

In the area above described, indications of natural gas are numerous in a zone extending from Ottawa along the south shore of Ottawa river and the north and south shores of the St. Lawrence as far as Quebec. These have been exploited in depth by boring at a number of places, but so far without locating gas in any large and lasting pools and without finding petroleum which, judging by slight indications found at various places, operators had hoped to find accompanying the gas.

In St. Hyacinthe district some 25 miles in an easterly direction from Montreal, in a group of deep borings a little natural gas was found under high pressure, but no petroleum. These borings were with one exception confined to a synclinal trough and did not reach the same horizon as that in which the gas, and occasional oil indications, are found in the Ottawa end of the district.

For reasons indicated above, and considering how few deep borings have been made in comparison with the extent of the district, it can only be concluded that the question of the existence of gas and oil in commercial and lasting quantities in the eastern Ontario-Quebec Palæozoic series is still an open one.

No information as to boring activities in Nova Scotia came to hand other than the records published, as in former years, by the Department of Mines of the province.

Correspondence was carried on in regard to the advisability of borings for water by the Farmer's Co-operative Creamery of Moncton and in connexion with proposed boring operations by the Trask Well Company of Berwick, N.S., on Grand Manan island. No reports of operations were received in reply to our invitation to co-operate.

The New Brunswick Gas and Oil Company have continued to send records of their operations and some 3,000 samples from eight wells were received during the year. The field, adjacent to Moncton, has been so systematically tested and developed by the company that most of their boring activities for some years past represent deepening of old wells to reach proved lower gas-bearing horizons.

Records Received from the Maritime Provinces: New Brunswick and Prince Edward Island

Locality	Total depth in feet	Number of samples received	Remarks
Albert, N.B., Stony Creek..	....	300	New Brunswick Gas and Oilfields, Ltd., Well 64
" " ..	....	410	" " " " 65
" " ..	....	508	" " " " 66
" " ..	....	506	" " " " 67
" " ..	....	508	" " " " 68
" " ..	....	510	" " " " 69
" " ..	....	500	" " " " 70
Queens, P.E.I., Governor island..................	25	4	Doherty Co., No. 1

On Prince Edward Island, in the vicinty of Charlottetown, the Henry L. Doherty Company of New York has commenced a deep boring and a number of samples have been received. In view of the intricate problems presented in the study of the various formations of the adjacent provinces of Nova Scotia and New Brunswick and their relationship to the strata constituting Prince Edward Island, the geological information resulting from any deep borings made in the island province will be of exceptional interest. The belief held many years ago that the coal measures of Nova Scotia and New Brunswick might be found to underlie the younger strata of the island led to the boring of five deep holes by the Dominion Geological Survey in the year 1909. Of these the shallowest was 1,670 feet and the deepest 2,082 feet. Geological studies had shown the presence of some seven flat anticlines in the strata and the borings were located on three of these as near the crest as feasible, so as to start as low in the formations as possible. The fragile nature of the strata passed through and the heavy flows of water under pressure encountered greatly added to the difficulties of the undertaking, but it was felt that, although no greater depth was attained, it was proved that coal seams did not exist at a depth at which they might be commercially worked. The records of these wells present a monotonous variation of soft shales, sandy shales, and sandstones, and no important change of formation was demonstrated. Should the underlying formations be reached in the present boring not only will relationships of great geological interest be established, but the possibility of encountering gas and oil in these lower formations will have been partly demonstrated.

OTHER FIELD WORK

Geology

Ellis Thomson. Mr. Thomson continued an areal geological and geographical survey of a part of the large area of "Keewatin" schists near Woman River, Ontario. This area is geologically similar to other large Keewatin areas which have been found to be well mineralized, and it is being mapped to facilitate prospecting operations. Iron formations, pyrite, gold, and lead-zinc minerals are known to occur in it. The area surveyed in 1925 lies within the Ridout quadrangle, between latitudes 47° 30′ and 47° 45′ and longitudes 82° 30′ and 83°. Further field work will be done before a report and maps are published.

R. C. Emmons. Mr. Emmons surveyed an area of Huronian formations in timber berths 195, 188, 182, and parts of the townships of Gould and Grassett, north of Thessalon, Ontario. The area contains small deposits of copper, but the survey was undertaken chiefly to obtain fuller knowledge of the extent and relationships of the Huronian formations. Work will be continued in 1926.

W. H. Collins. Mr. Collins commenced a detailed geological and geographical survey of the Espanola quadrangle lying between latitudes 46° 15′ and 46° 30′ and longitudes 81° 30′ and 82°, just west of the Sudbury nickel basin. The area contains some occurrences of gold, nickel-copper, and feldspar and affords a solution for some of the geological problems of the nickel basin. Work will be continued in 1926.

T. T. Quirke. Mr. Quirke continued a detailed geological survey near the mouth of French river, Ontario. The country extending from Killarney eastward along Georgian bay is underlain by a complex assemblage of granitic rocks and crystalline sediments which contains deposits of feldspar, garnet, pure quartzite, and other non-metallic minerals that are close enough to water transportation on the Great Lakes to make development possible. It is also of outstanding geological interest, inasmuch as it affords some means of correlating the succession of Precambrian formations in the Huronian region with that of the Grenville region. Work will be continued in 1926.

H. V. Ellsworth. Mr. Ellsworth studied the granites and pegmatites at Cutler, Webbwood, Creighton Mine, Killarney, Dill, and Ess Creek, all in the general vicinity of Sudbury, particularly with a view to finding radioactive and rare-earth minerals. This was in continuation of a systematic study of radioactive and rare earth minerals throughout Canada. A report upon this work is being prepared.

M. E. Wilson. Mr. Wilson completed a detailed geological survey of an area of Grenville and other crystalline rocks near Madoc, Ontario, and a systematic investigation of the deposits of talc, fluorite, gold, arsenic, pyrite, etc., that occur in this locality.

R. A. Pelletier. Mr. Pelletier surveyed geologically an area near Thurso, partly in Ontario and partly in Quebec. Work was done on either side of a railway which is being constructed northward from Thurso and will give readier access to this part of Quebec.

J. W. Goldthwait. Mr. Goldthwait commenced a study of the physical geography and Pleistocene geology of the St. Lawrence lowland, with a view to preparing a report similar in character to the recently issued "Physiography of Nova Scotia." It is expected that the field work will be completed in 1926.

F. J. Alcock. Mr. Alcock made a systematic examination of lead and zinc occurrences in eastern Canada. This work will be continued in western Canada in 1926 and when complete a report will be prepared upon lead and zinc occurrences in Canada.

W. V. Howard. Mr. Howard commenced an areal geological survey of the Carleton quadrangle, between latitudes 48° and 48° 15′ and longitudes 66° 30′ and 67°, on Chaleur bay. This area contains an unusually full and well-exposed succession of Palæozoic formations, both sedimentary and volcanic, study and mapping of which should contribute importantly to knowledge of the geology of Gaspe and New Brunswick. The work will be completed in 1926.

W. L. Uglow. Mr. Uglow made a systematic examination of manganese deposits in New Brunswick and Nova Scotia with the intention of continuing such work in western Canada with a view to preparation of a report upon manganese occurrences in Canada. The untimely death of Dr. Uglow will delay the completion of the proposed report.

H. D. Squires. Mr. Squires made a detailed geological and geographical survey of an area of granites and altered sedimentary formations near St. George, New Brunswick. A report and a map are being prepared.

W. A. Bell. Mr. Bell revised existing geological maps of areas in Nova Scotia underlain by rocks of the Carboniferous system. A new edition of the geological map of Nova Scotia, No. 39 A, which is now being prepared for publication, will contain this new information. The Carboniferous rocks, which contain a wealth of useful minerals, will be subdivided into three parts corresponding to their contents of economic minerals, as well as to their geological character.

A. O. Hayes. Mr. Hayes resumed a detailed geological survey of an area around and east of St. John, New Brunswick, upon which he had been engaged at times between 1913 and 1920, when he resigned from the service of the Geological Survey. The area contains an unusual assemblage of early Palæozoic rocks, which have been rendered classic by the researches of G. W. Matthew, L. W. Bailey, and other geologists.

E. R. Faribault. Mr. Faribault continued near Bear River, Nova Scotia, the systematic geological survey of Nova Scotia upon which he has been steadily engaged for many years.

Topography

D. A. Nichols. Mr. Nichols carried out the primary traverse for the control of the Key Harbour map-sheet, Ontario. This sheet lies between latitudes 45° 45′ and 46° 00′, and longitude 80° 30′ and 81° 00′. The traverse was carried along the Canadian Pacific railway from Pickerel river south to Naiscoot station, and along the Canadian National railway from Pickerel river to Mowatt station, including the spur line to Key Harbour. Connexion was made to the astronomical station at Pickerel. Permanent monuments were established about every 2 or 3 miles along the routes. The position of these in latitude and longitude, based on the position of the astronomical station at Pickerel, are computed and are available for future reference.

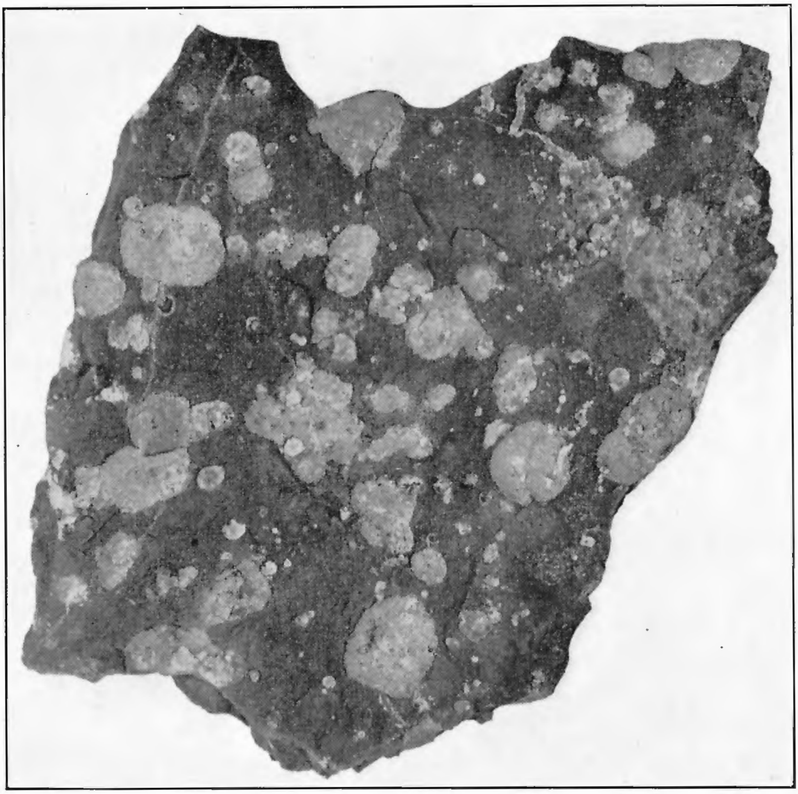
A. G. Haultain. Mr. Haultain carried out geographical surveys to complete the French River sheet, latitudes 46° 00′ to 46° 15′ and longitudes 80° 30′ to 81° 00′, and the Panache sheet, latitudes 46° 00′ to 46° 15′ and longitudes 81° 00′ to 81° 30′. All of this work near Georgian bay is being carried out in connexion with the above-mentioned geological investigations by T. T. Quirke. Mr. Haultain also carried a transit and tape traverse along the Nipissing Central railway from Swastika to the Interprovincial boundary. This traverse is for the control of geographic surveys in the area. The Key Harbour, French River, and Panache sheets will be uniform in size and on a scale of 1 inch to 1 mile.

R. Bartlett. Mr. Bartlett commenced work on the Loch Lomond sheet. This sheet lies between latitudes 45° 15′ and 45° 30′ and longitudes 65° 30′ and 66° 00′. This work is being carried out in connexion with geological investigations, by A. O. Hayes, in the area. Very bad weather and heavy fogs greatly retarded the progress of the work. Mr. S. C. McLean carried out the triangulation control for the Loch Lomond sheet.

K. G. Chipman. Mr. Chipman completed the topographical surveys for the Margaretville sheet, latitudes 45° 00′ to 45° 15′ and longitudes 65° 00′ to 65° 30′; for the Bridgetown sheet, latitudes 44° 45′ to 45° 00′ and longitudes 65° 00′ to 65° 30′; and also for the Granville Ferry sheet, latitudes 44° 45′ to 45° 00′ and longitudes 65° 30′ to 66° 00′. About one-half of the Digby sheet, latitudes 44° 30′ to 44° 45′ and longitudes 65° 30′ to 66° 00′, was also completed.

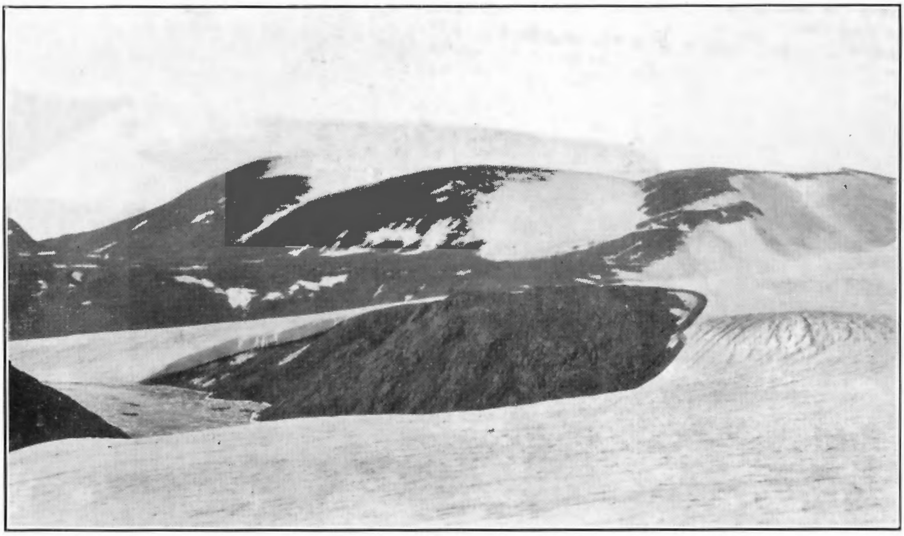
W. H. Miller. Mr. Miller completed the topographical surveys for the west half of the Springhill sheet. The area embraced in this half sheet is between latitudes 45° 30′ and 45° 45′, longitudes 64° 00′ and 64° 15′. The coal mines around Joggins are included in this area.

S. C. McLean. Mr. McLean, in addition to providing triangulation control for the Loch Lomond sheet, N.B., completed the triangulation of about 422 square miles of territory for the control of the Springhill and Oxford sheets. A monumented traverse was also run from Joggins to Westchester via River Hebert, Southampton, and Springhill. Permanent reference posts were set about every 2 or 3 miles along the routes followed. The primary traverse in the southwest was continued from Meteghan to Yarmouth. This work is the same as has been carried on for the last two years.



A Dalmatianite showing spotted texture, many of the smaller white spots are amygdules. (Page 41.)

B. Central Destor, looking north from the east-west centre line of the township. (Page 84.)



A. Fram Havn, Rice strait, Ellesmere island. View looking south from hill north of harbour. Arm of glacier is seen entering Rice strait in two lobes, splitting around what was probably once an island in the strait. (Page 136.)

B. Croker bay, North Devon island. View looking northwest into Croker bay, and showing elevated sea beaches with sea-cliffs now 3 miles inland. (Page 138.)

PLATE III

Dundas harbour, North Devon island. View looking west across the harbour. Just above the ship, and on the right, is visible the unconformity between low-dipping gneiss below, and horizontal limestone above. (Pages 137, 138.)

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