CANADA

DEPARTMENT OF MINES

HON. CHARLES STEWART, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

GEOLOGICAL SURVEY : Econ. Geol. Div.

W. H. COLLINS, DIRECTOR

Summary Report, 1928, Part C

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OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
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MICHIPICOTEN RIVER MAP-AREA, ALGOMA DISTRICT, ONTARIO

By L. J. Weeks

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INTRODUCTION

Michipicoten River map-area lies between 47° 45′ and 48° 00′ north latitude and 84° 30′ and 85° 00′ west longitude. It includes a land area bounded on the west by the shore of lake Superior south and west of Michipicoten Harbour. The Algoma Central and Hudson Bay railway roughly parallels the eastern boundary and lies about 2 miles west of it. The northern boundary passes about 3 miles north of Michipicoten Harbour and the south boundary crosses the Lake Superior shore about midway between cape Choyye[1] and Brûlé point. The present account of the geology and mineral resources of the district is to be supplemented in, it is hoped, the near future by a geological map (Michipicoten River sheet) on a scale of 1 inch to 1 mile.

Gold was discovered in Michipicoten in 1897. Later prospecting brought to light immense deposits of iron ore. Active development proceeded for some years when interest in the region slackened. Lately interest has revived and prospecting is again proceeding.

The writer was detailed in 1928 to complete the study and mapping of the geology of the area, which previously had from time to time since a very early date engaged the attention of officers of the Geological Survey and of the Department of Mines, Toronto. Control lines had been surveyed by H. N. Spence, of the Geological Survey, along the Algoma Central railway, Michipicoten river, the shore of lake Superior and Anjigomi lake—Oldwoman River route. These surveys with the existing township surveys served as a base to which has been added information gained by the writer.

The writer wishes to gratefully acknowledge courtesies rendered in the field by officials of the Power and Mines Corporation, the Pioneer Mining Corporation, the Engineers Holding Company, Mammoth Metals Company, the Wawa Syndicate, the Algoma Central railway, and the Algoma Steel Corporation. Much aid was also received from individual prospectors. Messrs. E. J. Lees, W. E. White, and D. E. McLarty acted very efficiently as assistants during the entire season.

[1] Geographic Board spelling, Chaillon.

The main line of the Algoma Central railway passes north through the map-area, close to its eastern boundary. A branch line from Hawk junction, north of the map-area, runs to Michipicoten Harbour in the northwest corner of the district. The map-area is crossed from east to west by Michipicoten river which is navigable by small boats except for 3 miles below High falls. West of the main line of the railway and south of Michipicoten river the district is an unsettled wilderness traversed only by a few canoe routes along which many of the portages are overgrown with brush and difficult to find.

For 5 to 10 miles inland from lake Superior the general character of the country is rugged. In this part drift-covered areas are few except in the valleys of the larger streams. As a rule, the streams where they traverse this section are not navigable without a great deal of portaging. This condition is shown well by Michipicoten and Magpie rivers. Both are large streams and both are navigable downstream to High and Steephill falls, respectively. Below these falls, both rivers are a series of rapids and falls.

The eastern part of the map-area, in the vicinity of Anjigomi lake and northward, exhibits totally different characteristics. Instead of rugged, steep, rocky slopes there are rolling hummocky hills separated by large areas of sand-plains. Bare rock slopes do occur, but are comparatively few in numbers.

Practically the whole map-area is drained by Michipicoten and Oldwoman rivers. The latter is undeveloped, either for power or for driving logs. High falls on Michipicoten river is 128 feet high and capable of developing 7,500 horsepower. An existing power plant is equipped to generate 1,700 horsepower which is being utilized by the Grace and Jubilee mines. During 1928 work commenced with the object of increasing the output and of transmitting power to Sault Ste. Marie.

GENERAL GEOLOGY

An area immediately north of Michipicoten River map-area has been studied in detail by Collins and Quirke.[1] A part of the area mapped by them lies within the northern limits of the Michipicoten River sheet and was not examined by the present writer. Since a very full discussion of the geology is given by these authors, and since the geologic history of the two areas is essentially the same, it is thought advisable here to give only a summary account of the rock types found with detailed notes only where warranted by special cases.

Collins used as his chief horizon marker a sedimentary group which he termed the Doré series. Associated with this series are two igneous complexes, one older and the other younger than the Doré strata. The pre-Dorean consists of schistose volcanic flows and tuffs. An erosional unconformity is believed to exist between the pre-Doré complex and the Doré series, since the bottom of the Doré series contains pebbles exactly coinciding in characters with the schists and other rocks composing the pre-

[1]Collins, W. H., and Quirke, T. T.: Michipicoten Iron Ranges, Geol. Surv., Canada, Mem. 147, pt. I (1926).

Dorean assemblage. Collins also finds granitic rocks with the older assemblage and believes they are pre-Doré since granite pebbles occur in the Doré series adjacent to the granite areas. Both Doré and pre-Doré rocks occur in the Michipicoten River map-area, but only in the northern part which had already been studied and mapped by Collins.

Younger than the Doré is a complex of volcanic rocks, sediments, and iron formation. This group has undergone intense regional metamorphism accompanied by folding and faulting and is believed to be well represented in the area examined by the writer.

All three groups are cut by granitic intrusives and by still younger diabase dykes belonging to two sets: an older consisting of quartz diabase, and a younger which occasionally contains olivine.

As mentioned above, neither the Doré series nor the pre-Doré assemblage occurs in the part of the area examined by the writer. The Doré series, as mapped by Collins, is represented by a belt about 1½ miles wide extending from Doré river and the shore of lake Superior just west of the map-area, across the northwest corner of the map-area to and along the Algoma Central railway. The belt within the confines of the map-area is 3 miles long and is terminated on the east by a fault. On the north side of the belt lie the pre-Doré rocks. All the rocks lying south and east are younger than the Doré strata and occupy all but about 8 square miles of Michipicoten River map-area.

POST-DORÉ VOLCANICS

Collins found a vast series of volcanics which he classifies as post-Doré. These rocks he traced along the shores of Michipicoten harbour to the mouth of Michipicoten river, and also followed them eastward to a point north of High falls on Michipicoten river. The same rocks have been traced by the writer south along lake Superior to Brûlé bay, where they are cut by a large granite batholith. Nothing resembling the Doré series was found, although small, isolated patches of sediments, chiefly conglomerates, were detected. It is, therefore, believed the volcanics in the area south of Michipicoten river are post-Doré. Evidence supporting this belief is the presence of iron formation between Island lake and lake Superior. Collins finds iron formation to be present only in the post-Doré assemblage.

The area of post-Doré volcanics extending along the Lake Superior shore to Brûlé bay is bounded on the east by a granite batholith whose western edge runs northeasterly from Brûlé bay. A granite body, 3 miles long by ½ mile wide, lies within the area between Michipicoten river and Pike, Round, Cross, and Twin lakes. In the north, the volcanics extend eastward in a band that narrows eastward, crosses Anjigomi lake at the first narrows as a belt about ½ mile wide, and, gradually narrowing, ends to the eastward in the granite. North of Michipicoten river, the volcanic rocks continue to Wawa lake, but are penetrated by many small stocks of granite. It is in this northern area of the post-Doré volcanics that most of the known mineral deposits occur.

A second area of volcanics, also probably post-Doré, lies in the south part of the map-area. It follows the shore of lake Superior, south of Oldwoman bay. Its outline within the map-area is triangular. Eastward it is limited by granite and possibly granite bounds it on the west not far offshore, for islands and shoals along the coast are of granite.

The post-Doré volcanics are cut by many diabase and porphyry masses. In the wooded sections it is usually difficult to determine whether a small outcrop belongs to the post-Doré volcanic group, or to a later porphyry mass. In the mining area, where considerable stripping has been done, and on the shore of lake Superior where in many places bare rock is exposed for a hundred yards inland, the quantities of intrusive diabases and porphyries are made evident.

Probably the greater part of the post-Doré volcanics are of pyroclastic origin, varying from volcanic breccias with fragments up to over a foot in diameter, to fine-grained tuffs whose composition can only be determined by means of the microscope. Those rocks which can be definitely determined as being lavas are probably all ellipsoidal greenstones. They are abundant immediately south of Oldwoman bay and south of Noisy river, but were not recognized in many other places.

South of Oldwoman bay the volcanics are mostly massive basalts and other basic flow rocks with here and there well-developed ellipsoidal structures. A thin section of one of the more massive phases showed the rock to be almost entirely altered to chlorite. Long, narrow laths of plagioclase and small phenocrysts of augite were originally present. The augite is now completely altered to large crystals of chlorite and the plagioclase replaced by small radiating growths of the same mineral. The chlorite individuals show no signs of parallel orientation, but there was evidence of shearing having taken place after the chlorite had formed.

Most of the rocks studied in thin sections are tuffs. As a rule these rocks are much altered to chlorite. Many of the fine-grained tuffs contain fragments of lava and as these fragments increase in size and number a fairly complete gradation is afforded to the coarsest breccias.

Some quite acid tuffs from north of Brûlé harbour were examined microscopically. One in particular is quite fresh and consists of minute angular fragments of quartz and plagioclase in a mass of finer-grained, slightly chloritized material. A few fragments of a rock consisting essentially of quartz and albite-oligoclase are present. Another rock examined came from near Rabbit Blanket lake and was termed a tuff in the field. It was found to be about 90 per cent chlorite, the crystals being developed with parallel orientation.

Evidences of local shearing are quite plentiful throughout the area, but in only one locality, near Twin lakes to the south of the Twin Lakes batholith, is a regional schistosity imparted to the rocks. The rock in the immediate vicinity of the upper Twin lake is a fine-grained tuff with a pronounced slaty cleavage roughly paralleling the nearly granite batholith. Rocks of the same type and with a similar cleavage occur in places for some miles to the westward. A thin section of a rock from the upper Twin lake shows it to be a much metamorphosed, fine-grained rock which originally contained phenocrysts of plagioclase and quartz. It is almost entirely altered to chlorite with a slightly parallel development of the crystals.

IRON FORMATION

Compass deflexion was observed in several places south of Michipicoten river, but in only one locality was it definitely determined to be due to iron formation. In this locality, iron formation outcrops on the Lake Superior shore a short distance north of Smoky point. It is there composed of alternate bands about 1 inch wide of quartz and iron-rich material. They are very much contorted, but strike on the average about north 15 degrees west and dip west 70 degrees. Inland between this locality and Island lake, very small exposures of iron formation were found in three places.

Iron formation, known as the Gibson range, also outcrops on Firesand river about 2½ miles southeast of Wawa lake.

POST-DORÉ INTRUSIVES

A large part of the map-area is underlain by a granite batholith. Nearly the whole length of the east boundary is underlain by the granite. To the west the batholith is bounded by the volcanic rocks and only reaches lake Superior between Brûlé harbour and Oldwoman bay. Two distinct bodies lie within the area of the volcanic complex. One, just south of Wawa lake, has been noted by Collins. The other lies between Michipicoten river and a chain of lakes running between Pike and Twin lakes.

The border phases of the Wawa Lake granite vary from the normal coarse granite of the larger masses, to fine-grained porphyries scarcely distinguishable from acid volcanics. Masses of volcanic rocks occur throughout the granite area and apophyses and dykes of granite cut the schists for considerable distances from the contact. These general conditions suggest that the present land surface is not far below the level of the original roof of the batholith. Practically all the metalliferous deposits of the area have been found in the vicinity of the Wawa Lake batholith.

The second of the smaller granite areas, which might be referred to as the Twin Lakes batholith, varies much in texture, especially near the borders, but the variations are not so marked as in the Wawa Lake body and the border phases, distinguished from the surrounding volcanics. Furthermore, only a few bodies of granite extend into the volcanics. During the summer of 1928 practically the first active interest was taken in this part of the area and as a result several properties were staked.

Immediately south of Island lake the main granite body exhibits, at its contact with the schist complex, characteristics very similar to those found at the edges of the Wawa Lake batholith. The granite shows a large variety of textures and varies from very coarse granite to quite fine-grained granite porphyry. In places it is difficult to determine the boundary between the granite and the volcanics so intimately are they intermingled. The granite mass also enters the volcanic area in a narrow apophysis about one mile long. Both rock types occur isolated within the main mass of the other. So far as known no prospecting has been done in this locality.

The granite within the confines of the map-area varies in composition between a true granite and a granodiorite. Usually it consists of microcline, quartz, and albite in varying proportions. Biotite is usually present and in some cases, as in a specimen from Rabbit Blanket lake, it is one of the predominant minerals. Near the contact on Brûlé harbour, the granite is bordered by a fine-grained aplite, consisting entirely of quartz, orthoclase, and a little plagioclase.

Whether all the granites are of the same age is open to question. Definite evidence was found in one locality on the Nipissing Central railway that some difference in age exists in the larger mass, for at this locality pink and grey granite were found intermingled in an outcrop, one intruding the other.

Porphyritic rocks cut the volcanic complex. They are particularly abundant around the Wawa Lake batholith and have been termed porphyrite by Gledhill and "tapioca porphyry" by the prospectors. They appear to intrude the volcanics in irregular masses. They are mostly greyish blue and have a dense groundmass bearing irregular, lighter coloured phenocrysts. Microscopically examined they are found to be more or less altered with the development of chlorite. The phenocrysts are usually of quartz and albite or albite oligoclase, or of plagioclase alone. In the quartzose types the groundmass is often predominatingly quartz with a little plagioclase.

These rocks are generally conceded to be allied to the granites. They are most plentiful in the area around the border of the Wawa Lake batholith and probably represent a later or final stage of the granitic invasion.

Small, usually basic, intrusive masses cut the volcanic complex. Of these a group of diabase dykes is younger than the granites, as the dykes may be seen in many places cutting the granite. Collins recognizes two groups of diabase intrusives distinguishable both by their composition and degree of alteration. The older is diabase and normal diabase; the younger and the more plentiful is a very fresh-looking diabase which occasionally contains olivine.

DESCRIPTIONS OF MINERAL DEPOSITS

The first discovered mineral deposit in Michipicoten district was an occurrence of iron ore found in 1866 at Gros cap. The first gold discovery was made in 1897 on Wawa lake and Wawa became a "city" almost overnight. Unfortunately, much of the early efforts were directed to the nearby sand-plains of Magpie river then believed to carry placer gold, but there is no record of any gold ever having been found in these sands. Considerable work was done in the bush, remnants of which may still be found dotting the country between Wawa lake and Michipicoten river. The discovery of the Helen and other iron-ore bodies was due to this earlier search for gold. Development work was done on several properties and mills were erected, but shortly thereafter gold mining came practically to a standstill and remained in this state until recent years. At present the Cooper Gold Mines are doing extensive development work on their Jubilee Lake property; the Power and Mines Company has reopened the Grace; the Mackey Point Syndicate, Mammoth Metals Company, and the Engineers Holding Company are doing surface work on their properties; and in the summer season many prospectors are working in the bush.

Most of the more important deposits are in that part of the area mapped by Collins. These have been examined and reported upon by T. C. Gledhill, of the Ontario Bureau of Mines. His description of the active properties, in particular, is given in considerable detail. The present writer visited most of the properties, but in view of the detailed description given by Gledhill, it is proposed to confine detailed descriptions to discoveries and work done since Gledhill's visit in 1928.

GRACE PROPERTY

The Grace mine was one of the earlier gold producers in the region. Mining on the Grace vein in the early days was carried down to 300 feet and the first and second levels were stoped out. Recently the property was taken over by the Power and Mines Corporation. The old shaft was deepened to 400 feet and considerable drifting and blocking out of ore was done on the third and fourth levels. Surface work was done also on a comparatively recent discovery, the Nyman vein.

Grace Vein. The Grace vein is of the fissure type. It has been traced in an unbroken line some 400 feet. To the north it is believed to be faulted and veins having practically the same strike but offsets to the right are believed to be continuations of it. The vein varies in width from a few inches to 5 feet. Pinches and swells are very noticeable and at many of the pinches no trace of the vein is visible. In the workings of the Grace mine, several small faults have been encountered. The strike of the vein is about north 15 degrees west and the dip varies considerably, averaging about 70 degrees east. The wall-rock is a porphyry. Horses of sheared porphyry lie in the vein. The vein is cut by small lamprophyre dykes and values are said to be greater next to these dykes. When the original shaft was sunk, some spectacular specimens of native gold were reported to have been found.

Nyman Vein. This vein was discovered in 1927 by one of the employees of the mine, after whom it is named. At the time of the writer's visit, it had been stripped for nearly its whole length. The vein consists of fissure fillings in a shear zone. The fissures occur *en échelon,* each succeeding fissure occurring to the left of the preceding one. The fissure veins contain numerous horses of sheared country rock. The general strike of the shear zone is north 70 degrees west. A system of roughly parallel dykes a few inches to one foot wide of lamprophyres and related rocks cuts across the shear zone and is later than the vein filling. The dykes strike about north 30 degrees east. In only one case is the vein displaced by one of the cross dykes.

That there were two periods of vein filling is evidenced at the extreme easterly exposure of the vein where older granulated quartz is found alongside white glassy quartz which contains only a trace of gold.

The country rock is a quartz diorite-porphyry. It has undergone some deformation and contains small nodules consisting entirely of quartz, biotite, and sulphides. In these masses the biotite is idiomorphic against the quartz and in most cases against the sulphides. Occasionally the sulphides embay the biotite. A specimen of the diorite porphyry from a point west of the outcrop of the vein is finer grained and holds much disseminated biotite and sulphides. The crosscutting dykes are, in most cases, pinkish, very fine-grained rocks. Very little could be learned from the examination of a thin section owing to the extreme fineness of the grain. Calcite and hematite are present, the latter probably being the cause of the pink colour of the rock. The predominant mineral is a feldspar which is either orthoclase or anorthoclase. One very fine-grained lamprophyre dyke about one foot wide and bounded on each side by 2-inch wide dykes of the pink rock, appeared to be composed almost entirely of biotite.

Assays show that the vein material and the porphyry walls carry values in gold.

COOPER GOLD MINES, LIMITED, GROUP

The original Minto group of claims and several adjoining properties are controlled by Cooper Gold Mines, Limited, a subsidiary of the Pioneer Mining Corporation. The company has outlined an extensive development campaign which includes underground development of the Minto vein, diamond drilling and underground development of the Jubilee Lake property, and diamond drilling of the Cooper vein. At the time of the visit of the writer, all work was being concentrated on the Jubilee Lake property, the Minto workings being full of water.

Minto Property. The first shaft sunk on the Minto vein is at the east end of Minto lake. It was sunk on the incline of the vein to a depth of 100 feet and 1,700 feet of drifting was done on the first level. A new 3-compartment vertical shaft has been sunk by the present operators about 460 feet southeast of the old shaft. Drifts have been run at two levels and a crosscut has been run to near the first level in the old shaft.

The geological features of this property are discussed by Gledhill[1] who examined the property when the mine was unwatered.

Jubilee Lake Property. The vein on this property, known locally as the " Jubilee Break ", was discovered by Larry Peters in 1926. The property, after passing through several hands, came under the control of Cooper Gold Mines. They diamond drilled the property and commenced sinking an inclined shaft in the foot-wall. In September, 1928, the shaft was down to the 400-foot level and drifting was well under way with crosscuts spaced 100 feet apart.

Geological Features. The rocks for some miles around the Jubilee property and more particularly to the north, are remnants of the roof of the Wawa batholith and are volcanic rocks intimately mixed with intrus-

[1]Gledhill, T. L.: Ont. Bureau of Mines, vol. XXXVI, pt. II (1927).

ives of various characters. The volcanics near the contacts with the intrusives are, in many cases, intensely metamorphosed and silicified. The intrusive rocks are mostly granitic, but appear in many instances to be quite basic near contacts with the greenstones. Quartz porphyry also intrudes the volcanics.

Underground the mineral body appears to consist of a series of irregular, mostly small, quartz veins lying in an intense sheared and fractured zone in which the country rock has been much silicified and otherwise altered. Some of the country rock in the zone is so intensely altered that its original nature can be determined only with difficulty. At the surface the country rock is a schist sheared along planes striking north 15 degrees east approximately parallel with the longer axes of the mineralized body. The schist is now quartzose because of silicification.

The shaft was sunk in the foot-wall and from a depth of 325 feet to the bottom of the shaft at 400 feet passed through very hard, pink and grey, cherty, very fine-grained quartz traversed by veinlets of coarser quartz. On the fourth level, the cherty quartz is 15 feet wide in the cross-cut and is bounded by a much sheared greenstone.

The mineralized zone on the fourth level is in sheared, green, volcanic rocks. Quartz stringers run throughout the zone and in places predominate, so that the greenstone occurs as small horses. The mineralized zone strikes about north 20 degrees east and dips east 35 degrees. It lacks definite boundaries and the width to be mined will depend on assay values. The writer understands that on the fourth level a width of 30 feet will be blocked out. Diamond drilling preliminary to underground development revealed no values in the foot-wall, but underground workings disclosed values.

The mineralized zone is cut by many narrow lamprophyre dykes. Such faults as were observed cutting these dykes appear to be of small displacement. One fault marked by 1½ feet of gouge and crumpled rock displaced a lamprophyre dyke 2 feet.

Another vein or mineralized zone, the Jubilee vein, is on the east side of Jubilee lake. It was discovered in the early days and a shaft was sunk on it, but the gold content as revealed by assays proved to be too low. The Jubilee parallels and is not far distant from the Jubilee Break.

CORA AND STOBIE PROPERTIES

The old Cora mine and the Stobie property were examined by the writer. No work has been done on the Cora since it was examined by Gledhill. The main mineral occurrence on the Cora property is a silicified shear zone which may be the continuation of the Jubilee Break, from which it is separated by the north end of Jubilee lake. To the north of the Cora is a group of claims owned by James Stobie, and on these stripping has been done on a large width of sericitized schist cut by stringers of jaspery quartz. This schistose zone strikes north 5 degrees west. A 1½-foot vein also occurs on this property which may or may not be part of the silicified shear zone mentioned above. They are a considerable distance apart.

The schistose zones on the Cora and on the Stobie property have approximately the same strike as the Jubilee Break and possibly are a continuation of it.

COOPER AND GANLEY VEIN

The northern part of this vein is named the Cooper vein and is owned by the Pioneer Mining Corporation. The southern part is known as the Ganley vein and on it a shaft was sunk; the old boiler and hoisting machinery are still to be seen.

The northern part of the vein, or the Cooper vein, was prospected by the Pioneer Mining Corporation, but evidently results were not satisfactory as work was discontinued. The vein is a fissure vein striking about north 75 degrees west and lies in sheared volcanics and porphyries. Fragments of a coarse, basic intrusive occur on the Ganley dump. The vein has a fairly even width of about 2 feet and dips 43 degrees to the east. It is exposed by stripping for 300 feet north of the Ganley shaft. Some sulphides are present. No native gold was observed, although it is reported to occur.

MACKEY POINT SYNDICATE

The first gold discovery of the region was made on what is now the property of the Mackey Point Syndicate. Several old pits and trenches still exist in the vicinity of Mackey point in Wawa lake. Surface prospecting on the point and southeast from it was carried on during the summer of 1928. No work was being done at the time of the visit of the writer in September, but it is understood that more work was done later in the season. The veins on the point were examined and the writer found one or two places where stripping had been done to the southeast.

Mackey point is underlain by a dense, massive amphibolite traversed by a network of narrow veins most of which follow one or other of two directions: east, and north 10 degrees east. Most of the veins are a foot or so wide and some have been traced for lengths of over 100 feet. One vein is 2 feet wide. The vein filling is quartz, with, in places, some tourmaline. Free gold was observed in several places and at each of these places tourmaline was also present.

The property southeast of Mackey point is underlain by the Wawa granodiorite batholith with numerous roof pendants of volcanic or associated rocks.

Vein No. 404 was seen near a trail ¼ mile southeast of Mackey point. This vein is also called the Jubilee because it is believed by some to be a continuation of the Jubilee Break on the Cooper property already described. A little stripping had been done at this place. The strike is north 10 degrees east. The writer understands from the owners that since the autumn of 1928 this vein has been stripped for 600 feet and traced with considerable gaps for 2,200 feet. The width is said to vary from 6 feet to 65 feet. Sulphides are present in the vein. Vugs are lined with quartz crystals. At the stripping seen by the writer the " vein " consists of quartz stringers in sheared and silicified greenstone. The Schuman and other veins to the east could not be located by the writer at the time of his visit.

CLAIMS SOUTH OF MICHIPICOTEN RIVER

During 1928 increasing interest was being taken in the country immediately south of Michipicoten river and several blocks of claims were staked around two finds. The first discovery was made by Dubois on Twin lakes. Later a find was made by Frank Bishop on Round lake.

The showing on the Dubois claims is on the east side of the upper Twin lake, near a short portage (125 feet long) to a lake to the southeast. No person was on the property at the time it was visited, but some stripping had been done and the country round about had been recently staked. Quartz is exposed at two places about 100 feet apart, east and west. The two occurrences do not appear to be on the strike of one another. At the easterly, quartz is exposed for 6 feet and appears to be partly vein quartz and partly quartz replacing volcanics. The country rock was not exposed, but nearby it is a schistose volcanic. Some sulphides were observed, but no free gold. The writer understands that assays show the presence of some gold.

The Bishop group of claims was also staked during the summer of 1928. At the time of the writer's visit, at a place south of Round lake, a quartz vein having an exposed width of 20 feet was uncovered for a length of 180 feet. The strike is south 17 degrees east and the dips to the west. The country rock is mostly of volcanic origin, although some coarser rocks that are present may be intrusives. The quartz is milky white and holds small blebs of galena. The writer understands that further work has increased the known width considerably and that assays have shown gold to be present.

SOUTHWESTERN PART OF SUDBURY NICKEL IRRUPTIVE

By W. H. Collins

Illustration

In 1925 the writer commenced systematic geographical and geological mapping of the complex area of Precambrian rocks that lies south and west of the Sudbury nickel irruptive, with a view to approaching from this direction the still more complex stratigraphical and structural problems that exist in the immediate neighbourhood of the nickel irruptive. Information has been obtained for one map-sheet (Espanola) of the area between latitudes 46° 15′ to 46° 30′ and longitudes 81° 30′ to 82° 00′, and work has been commenced in the next quadrangle to the east. The nickel irruptive has been reached and some information has already been obtained about it that is perhaps worthy of publication ahead of the map-sheets and report which it is intended to issue later.

CHANGES IN MAPPING OF THE NICKEL IRRUPTIVE

The main sources of published information about the geology and nickel-copper ore deposits of Sudbury basin are the reports and accompanying maps by Coleman issued by the Ontario Department of Mines (volume 14, 1904, part 3) and by the Mines Branch of the Federal Department of Mines (Publication No. 171). Coleman showed that the nickel-copper sulphide deposits originated from the nickel irruptive and occur at or not far beyond the outer or basic edge of this great elliptical ring of igneous rock. Prospecting and mining experiences in the district have confirmed Coleman's opinion in convincing fashion and it is now generally accepted that the best place to search for new deposits is along the outer contact of the nickel irruptive.. Consequently some corrections in the mapping of a part of this contact may be of interest. These changes are represented in Figure 1, which has been made on the same scale as Coleman's maps in order to facilitate comparison.

Ninety per cent or more of the contact shown is hidden by sand-plains or swamps. Hence it seems unlikely that the mineral possibilities were adequately explored about a quarter century ago, when prospecting was most active. The methods of prospecting then employed for drift-covered country were trenching and drilling. To some extent the dip needle was used, because the pyrrhotite in the ore exercised a magnetic effect; but the observations were usually inconclusive because of other

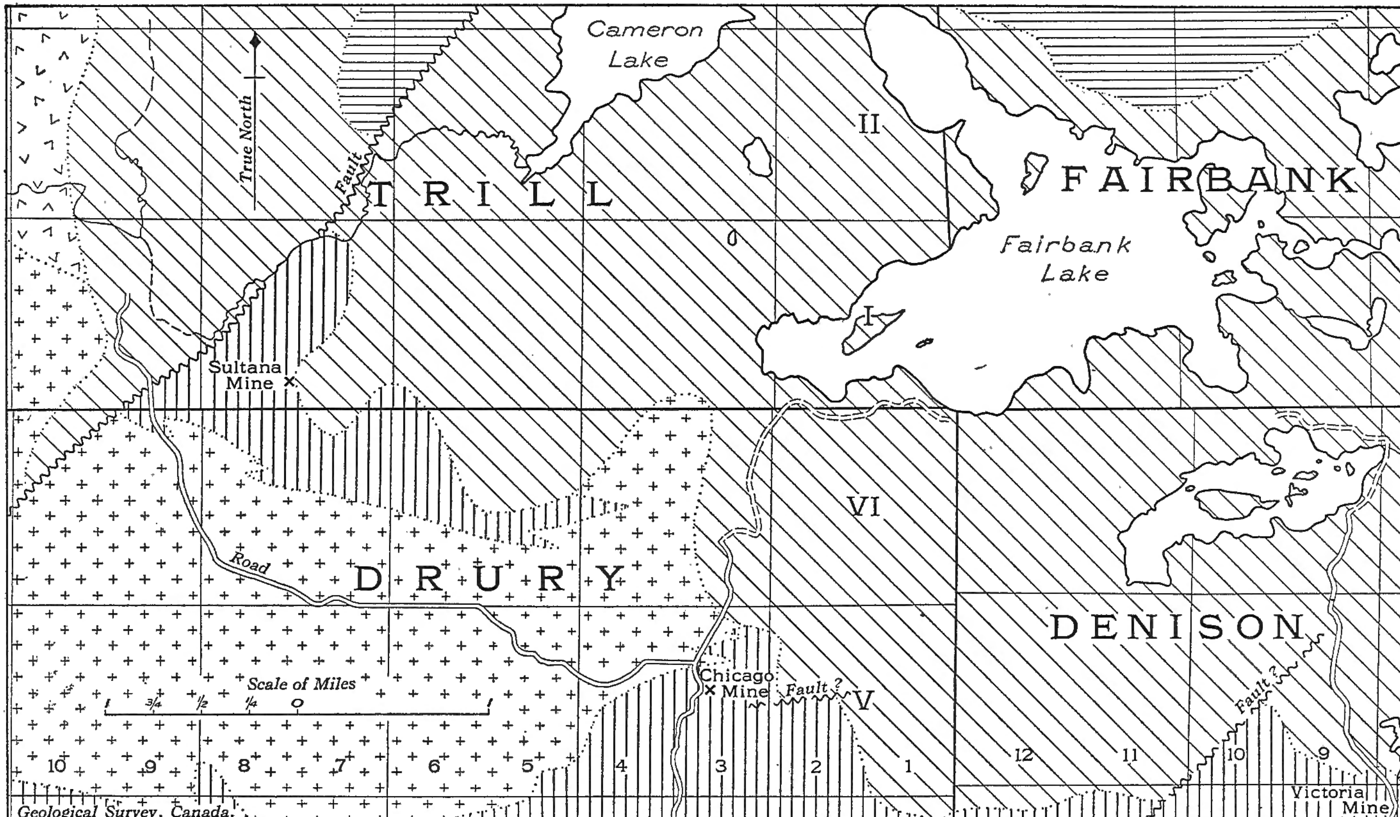

Figure 1. Southwestern part of Sudbury nickel irruptive. Formations in order of age are: Keewatin, vertical lines; Pre-Huronian granite, angle pattern; Whitewater series, horizontal lines; nickel irruptive, oblique lines; Killarnean granite, cross pattern.

magnetic effects in the rocks. Since then electrical methods of prospecting have been developed, that are particularly applicable to sulphide deposits. These electrical methods seem to afford a promising and relatively inexpensive means of exploring the southwestern edge of the nickel irruptive. A brief description of the contact from this standpoint, therefore, may not be amiss.

In concessions II and I, Trill township, the contact lies somewhere through a broad and level tract of sand and silty clay drained by Cameron creek. Most of it is covered by swamp or dry forest, but part of lot 9, concession I, is cleared for farming. Rock outcrops are mostly small and far apart. The contact cannot be determined closely, but appears to lie under the drier and more rolling sandy area away from Cameron creek.

The small point of the nickel irruptive that extends into Drury is in more rocky country, but the contacts lie in narrow, drift-filled depressions. The faulted contact that extends northeastward from this tip is under sandy drift everywhere except where it coincides with Cameron creek. There high, rocky hills rise on either side. From this fault towards the old Sultana mine the contact is under a wide, grassy valley filled with bouldery and gravelly drift. At the Sultana, what was once a swamp is now a dry, peaty area about 1,000 feet wide, covered with stumps. The curving contact in lots 7, concession VI, Drury, and lots 6 and 7, concession I, Trill, is under a partly forest-clad drift area of considerable size, with a hill of Keewatin rocks on the south. Across lots 6, 5, and the northwest corner of lot 4, concession VI, Drury, the contact follows a narrow valley up over a high, bare, rocky area, where it is exposed for several hundred feet, and then along the base of this rocky area, where it is under rock talus and a flat of silty clay covered sparsely with second growth. The bay that occupies lots 4 and 3, concession VI, Drury, is occupied mostly by a dense spruce swamp, and the contact at the bottom and along the east side of this bay can not be closely located. From the road to the fault indicated in lot 2, concession V, the contact lies in a narrow, wet depression flanked by rocky hills. Across the remainder of lots 2 and 1, concession V, it is largely in rocky country from which the forest has been partly burned. The undulating contact across lot 1, concession IV, Drury, and lots 12 and 11, concession IV, Denison, to the next indicated fault, is only approximately located in a dry, rolling area of bouldery drift, partly forested and partly burned. The fault indicated in lot 10 follows a marsh, but the remaining contact to Victoria mine is in wooded, fairly rocky country.

FAULTS

An opinion prevails that the lead-zinc deposits inside the nickel basin, of which the Treadwell-Yukon and Sudbury Basin properties are the best known, have also originated from the nickel irruptive and that they are localized along fault-planes that afforded channels for the ascending mineralizing solutions. On this theory, which has considerable supporting evidence, any fault within the nickel basin may be mineralized. However, the interior of the nickel basin is largely surfaced with clay and sand, and it is almost impossible to find faults. About the only clues to their existence and course are to be found in the rocky area underlain by the nickel irruptive.

There is fairly good evidence of a fault in the valley of Cameron creek. The nickel irruptive is offset for 2 miles along a fairly straight line that coincides for most of the distance with a narrow valley or trench. Judging by the apparent horizontal displacement of the nickel irruptive and of the Whitewater series the fault has a large throw and should be correspondingly long.

East of Chicago mine there is a sharp jog in the contact of the nickel irruptive, suggestive of faulting, and the rock along this line is noticeably more sheared than farther away.

There is another larger jog in lot 10, concession V, Denison, which may represent a fault. It lies in a marsh, in alinement with which are other marshes and ponds that occur across lots 5 and 6, concession I, Fairbank. Nearly in alinement, also, is a remarkable, slender tongue of Whitewater series sediments that extends across lots 5, 4, and 3, concession II, and lots 2 and 1, concession III, Fairbank. The Treadwell-Yukon deposits are roughly in line farther towards the northeast.

SUDBURY SERIES

Coleman classified as pre-Huronian a thick series of argillitic sediments and quartzites in Sudbury district, and called it the Sudbury series. This series forms a belt 100 miles long and as much as 5 miles wide.[1] Its relationships in time to the Timiskaming series, Doré series, and other early Precambrian sediments, are of considerable scientific interest and have been a subject for much speculation.

The present writer had a good opportunity to study the Sudbury series between 1914 and 1918, when he was engaged in restudying and mapping the Huronian formations along the north shore of lake Huron. He discovered that all the granites with which the Sudbury series is in contact are not pre-Huronian granites, but Killarnean, or late Precambrian; also that the Sudbury series and the Bruce series (lowest Huronian series) appear in several places to be in conformable contact. Some uncertainty arose, therefore, whether the Sudbury series is pre-Huronian or Huronian.[2] The more recent field work carried on since 1925, however, has revealed a substantial body of evidence for placing the Sudbury series in the pre-Huronian, beneath the major unconformity that separates the pre-Huronion from the Huronian, although the apparent concordance of Sudbury and Bruce series in places remains unexplained.

In the townships of Graham and Denison, and also in Baldwin and May townships, the Sudbury series is found resting against the Keewatin volcanics. Since on the opposite side the Sudbury series rests against the Bruce series, which is unquestionably younger, it follows that the Keewatin is older than, and stratigraphically below, the Sudbury series, though all these formations now lie nearly on edge. The passage from Keewatin to

[1] *See* Geol. Surv., Canada, Map 155A.
[2] *See* Geol. Surv., Canada, Mem. 143, p. 26.

Sudbury series is similar at all observed places. The main body of the Keewatin is volcanic material with no recognizable sedimentary members. But within a few hundred feet from the Sudbury series thin sedimentary members, apparently derived from Keewatin volcanic materials, begin to alternate with the volcanics. In this somewhat gradational fashion the Keewatin gives place to the Sudbury series. Except at the base, where it grades downward into the Keewatin, no volcanic members have yet been seen in the Sudbury series. The relationship seems to indicate that no unconformity exists between Keewatin and Sudbury series, and that volcanic activity, which characterized Keewatin time, died out and gave place in Sudbury time to sedimentary processes. The prevalent argillitic formation in the Sudbury series has a varve-like stratification suggestive of freshwater deposition, which accords with evidence in Michipicoten district[1] and elsewhere that the Keewatin volcanics and related sedimentary series (Doré, Sudbury, Timiskaming, etc.) are continental (hence probably freshwater) deposits.

The major unconformity that, on the above evidence, must separate the Sudbury series from the Bruce series, is evidenced in Baldwin township by undisturbed contact of a basal conglomerate of the Bruce series against the Keewatin and against the Sudbury series within short distances. Nevertheless, at High Falls, in Hyman township, in Waters township, and at several other places, the Sudbury series appears to grade conformably upward into the basal conglomerate of the Bruce series. The writer's efforts to reconcile this apparent contradiction of evidence have not yet been successful, but there appears to be a sufficient mass of evidence to justify assigning the Sudbury series to a position in the pre-Huronian just above the Keewatin.

[1]Geol. Surv., Canada, Mem. 147.

MINERAL DEPOSITS OF THE EASTERN PART OF RUSH RIVER MAP-AREA, WOMAN RIVER DISTRICT, ONTARIO

By H. M. Bannerman

INTRODUCTION

In the spring of 1928, the writer was instructed to commence a systematic geographical and geological mapping of Rush River map-area, Woman River district, Ontario. Work was started about the middle of June and continued to September. During this time micrometer surveys were made of the navigable waterways in the eastern part of the area; the rock exposures along the waterways were examined; land traverses, variously spaced, were run in order to study the intervening parts; and occurrences of commercially valuable minerals within this part of the area were accorded special attention.

The writer was ably assisted in the field by Messrs. Frank C. Foley and Stuart Pady. He wishes to express his gratitude to Dr. R. C. Emmons and Mr. Andrew Leith of the University of Wisconsin, for courtesies extended and for valuable discussion regarding the geology of the region. Thanks are also due to the Algoma Eastern Railway Company for their kindness in placing at the writer's disposal the report prepared for that company by Dr. J. A. Dresser, on certain portions of the area studied. To various prospectors interested in the area—particularly Mr. Jack Jessop of Sudbury—the author is indebted for useful information and for hospitality received.

LOCATION AND MEANS OF ACCESS

Rush River map-area lies within the confines of latitude 47° 45′ to 48° 00′ and longitude 82° 00′ to 82° 30′. From the main line of the Canadian National railway, it can most easily be reached by canoe routes leading southward from either Stackpool or Groundhog River crossing. To reach the eastern part of the area, the Stackpool route is, of course, the shorter of the two, and is, therefore, the most frequented by parties journeying to the mining claims near Rush (Sahkatawichtah) lake, where the more important known mineral deposits of the area occur. To reach the same claims by the Groundhog River route entails a greater distance of travel, but there is, on the whole, less portaging, and, if the traveller is loaded, it is the easier route. The area can also be reached from the main line of the Canadian Pacific railway by three routes which lead northward from Biscotasing, Woman River, and Ridout respectively. The distance by any one of these routes is, however, considerably greater than that travelled when approaching the area from the north.

PREVIOUS WORK

Map 155A, Geological Survey, Canada, is the only geological compilation that embraces the entire sheet. The area is briefly referred to by Robert Bell in his report, published 1877, on explorations carried on between lake Huron and James bay. W. A. Parks made a reconnaissance along the main waterways and along the Algoma-Sudbury mining division boundary line, in 1899. The iron range was studied in 1909 by R. C. Allen, and J. A. Dresser made a geological examination of parts of the area in 1914 in the interests of the Algoma Eastern Railway Company. T. L. Tanton conducted a geological reconnaissance of the northern part of the area, in 1915, and examined the Jefferson claims in the townships of Genoa and Marion. The iron range is again briefly described by Lindeman and Bolton in their report on the iron ores of Canada, published 1917, and, in 1918, A. H. A. Robinson visited the eastern part of the range. Robinson's report contains several analyses, taken from different parts of the range, particularly those parts which are high in sulphur content. In 1925, the section of the iron range that lies east of Rush river was studied by E. S. Moore. Moore's report is accompanied by an excellent map and treats in considerable detail the economic possibilities of this section of the area.

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SURFACE FEATURES

The area comprises a part of the Canadian Shield, and lies just north of the height of land forming the divide between the waters of Hudson bay and those of the Great Lakes. Topographically, it is one of low relief, characterized for the most part by low, hummocky ridges, and numerous lake basins. The lakes are connected by streams that are essentially sluggish, but interrupted here and there by small falls and rapids as they decant the waters from one lake basin to another. Muskeg and glacial till cover a large percentage of the area, and in many places, especially in McOwen and the eastern part of the township of Genoa, long, narrow gravel ridges occur, which are probably eskers. Some of these ridges are upwards of 2 miles in length, and rise to a height of 70 feet above the level of the surrounding plains. They follow a somewhat sinuous course, but their general trend is about north 20 degrees east. Usually they terminate in sandy plains of considerable dimensions. These plains contain many small, undrained ponds or lakes that are undoubtedly kettle-holes. The sandy plains thus, in all probability, are Preglacial deltas, which owe their origin to outwash from glacial streams.

GENERAL GEOLOGY

The bedrock of the area, so far investigated, may be conveniently divided into three main groups. All of these are of Precambrian age. The oldest group is an assemblage of schistified lava flows, pyroclastics, iron formations, local bands of clastic sediments, and intrusions of greenstone, together with a few ultra-basic dykes. These rocks are commonly spoken of as the "Keewatin", hence, in the following report, this term will be adopted to designate the whole of this group. The second group is intrusive into the Keewatin, and is composed dominantly of granites and gneisses, associated with which are numerous dykes and sills of diorite, altered diabase, and quartz feldspar porphyry; the third group consists of a profusion of fresh-looking dykes of olivine-bearing diabase, probably of Keweenawan age.

KEEWATIN

The Keewatin series underlies a large part of the area west of Rush lake, and a relatively narrow band of these schists which extends across the north end of that lake has been traced eastward as far as the eastern boundary of the sheet. This eastern extension is represented dominantly by lava flows of a basic to intermediate composition, with which are intercalated more or less insignificant amounts of sedimentary material. All of these have been profoundly metamorphosed, so that they now consist of green and greenish grey schists. North of Rush lake the strike of the schists is 10 degrees south of east. East of here the trend swings slowly toward the south for a distance of about 4 miles, thence it turns eastward, and the band crosses the west boundary of Whalen township between mileposts 4 and 5. The average width of the band throughout this distance does not exceed one mile, and at the eastern boundary of the area it is less than ½ mile wide. It is flanked on either side by granites that are intrusive into the schists, and near the contacts it is invaded by numerous dykes of diorite and pegmatitic composition.

Northwest of Rush lake the Keewatin contains a much greater percentage of acidic and pyroclastic material, and the occurrence here of relatively large and persistent iron formations adds to the complexity of the series. The iron formations consist of interbanded silica and iron oxides, carbonate, and in some cases, pyrite, with which are associated rather large replacement deposits of iron carbonate and sulphides. The range extends in a general southwesterly direction from the north end of Rush lake across the townships of Genoa and Marion, into Heenan. The banded silicia member is associated with andesitic tuffs and flows, and north of the iron range, for a distance of a mile or more, the dominant rock composing the Keewatin complex is of this composition. Local bands of more acidic material do occur here, but they were decidedly inferior in amounts.

South of the iron range, however, the rocks are dominantly acidic, composed for the most part of buff to cream coloured rhyolite tuff, containing numerous sporadically arranged coarse pyroclasts of felsitic composition, with which are associated local bands of quartzose clastic sediments. This member of the series has been traced from a point approximately one mile east of the Marion-Genoa township boundary, southwestward as far as Woman River. Throughout this distance it lies wholly on the southeast side of the iron formations, with the exception of one or two localities just east of Rush river where local cross folds and structural disturbances cause it to appear on both sides of the banded silica. The actual thickness of this member is not known. It is cut off on the southern side by the mass of granite that occupies the northeast shore of Rush lake. The rock is very schistose and for the most part displays no banding of a primary nature. It is cut by numerous dykes and irregular-shaped intrusions of greenstone. These intrusives are greatly metamorphosed and have been rendered quite schistose. Along with the rhyolitic tuff, they have been subjected to considerable carbonatization—a feature common only to the schisted rocks that lie to the south of the banded silica member of the iron range. From the similarity in degree of metamorphism it seems probable that these greenstones are derivative of a comparatively late stage in the igneous activity of the Keewatin.

DIORITES AND ALTERED DIABASES

Besides being invaded by the batholithic intrusives, the Keewatin series are cut by sills, dykes, and irregular-shaped masses of rocks, of intermediate composition. These seem to be characteristically developed in the regions immediately adjacent to the granitic contacts, and they are typically exposed in the township of Genoa northeast of Rush lake. On the whole they are compact, greenish grey rocks. The larger masses are upwards of 5 mm. in texture, but quite variable. Many of them display shreds of diabasic structure, some of them are gabbroic, but generally, they can best be described as diorites. They are all quite altered. In thin section they are found to consist, dominantly, of green and greenish blue hornblende and chlorite, with epidote, and a mesh work of altered lime-soda feldspar. Most of the sections contain some quartz, and a few remnants of augite have been observed. Iron ores occur abundantly in some of the slides, both as primary blebs and octahedra of magnetite, and as fine dust-like reaction products. Some sections contain an abundance of uralite surrounding zoisite, and remnants of plagioclase in a manner that suggests a former well-developed diabasic structure. Small crystals of apatite, and some pyrite and pyrrhotite are also present. The platy minerals are arranged haphazardly and the slides do not show much evidence of crushing.

The altered condition of these intrusives renders it difficult to distinguish them, where the contact relations are not exposed, from portions of the Keewatin lavas that have been recrystallized, under the influence of the invading granitic magma, into coarse-grained metabasites. They are, however, definitely intrusive into the Keewatin. In some places they occur as well-defined dykes cutting across the schists. In other places they resemble small stocks from which ribbon-like apophyses radiate, but more often they are present as thin sills paralleling the schistosity of the older rocks. Small stringers of epidote, quartz, and, in some cases, potash feldspar ramify many outcrops of this rock, and at various locations, dykes of quartz feldspar porphyry cut members of this intrusive assemblage.

The Keewatin rocks along the contacts of these dioritic masses have been subjected to an excessive amount of chloritization. This is particularly noticeable wherever the diorities cut the rhyolitic tuff. In such cases the tuff is altered to a pale green chlorite-sericite schist, in decided contrast to the usual buff-coloured sericite schist so characteristic of this member. A good example of this is exposed on claim S3693 where the chloritization of the tuff is so complete that its tuffaceous character can only be recognized by virtue of fragmentary structure, or by, continuously, tracing it to parts less influenced by the dyke.

The age of the altered diorities and diabases, and their relations to the granite, are not definitely determined. They cut across folded structures in the volcanics; hence they are clearly post-Keewatin. Quartz feldspar porphyry dykes have been observed to cut them, so that they are older than the porphyries. The age of the porphyries, however, cannot be stated positively from the data at hand, but their field distribution together with their petrographic character suggest that they are probably a differentiate of the granitic magma. If this be so, then it seems likely that the diorites are also older than the granite. Their distribution, however, together with the fact that, though they have been subjected to considerable hydrothermal alterations, they have not undergone any great amount of crushing, would seem to indicate that they are probably not greatly older than the granites, if indeed they do not constitute an early or border facies of the same magma.

BATHOLITHIC INTRUSIVES

Except for the narrow band of Keewatin schists described above, the eastern part of the area is underlain by rocks of granitic composition. These rocks are largely pink to greyish pink and of medium texture. Locally, they assume a gneissose structure, but are for the most part massive. Essentially, they are composed of orthoclase and microcline, a minor amount of oligoclase, and an abundance of quartz. The ferromagnesian mineral present is usually biotite. Several outcrops of hornblende granite and local bodies of hornblende syenite were observed, however, and near the Keewatin boundaries a greenish hue is sometimes imparted to the rock by the presence of an abundance of epidote and chlorite.

QUARTZ PORPHYRY DYKES

Northwest of Rush lake numerous small dykes of quartz and feldspar porphyry occur. Olivine diabase dykes being absent, these intrusives are the youngest rocks in this part of the area. They cut the iron formations and associated rocks at many places along the range, and on claims W.D.715, S3693, and S5991, they have been observed to have cut the dioritic intrusives. Near the granite mass, on the north side of the lake, they are essentially feldspar porphyries, with a minor amount of small quartz phenocrysts, but farther west they become typical quartz porphyries, quartz phenocrysts upward to ½ inch in diameter being present in profusion. These dykes seem to radiate from the mass of granite that occupies the northwest side of Rush lake, and are tentatively believed to be derived from the same magma.

OLIVINE DIABASE

A large number of olivine-bearing diabase dykes occur in the area. These dykes are the youngest rocks that occur in the part of the area under discussion, and are probably Keweenawan in age. They vary in width from a few inches up to 90 feet and the majority of them trend a few degrees west of north. The smaller dykes display typical diabasic structure, but the larger ones are more or less granitoid. They are exceptionally fresh as compared with any of the other dark coloured rocks in the area. Essentially they are composed of pyroxene and laths of labradorite. Olivine is present in small amounts, and some slides show considerable quantities of titaniferous magnetite and a little pyrrhotite. The contacts of these dykes with other rocks are clear cut, and very little metamorphism has been induced by their intrusion.

ECONOMIC GEOLOGY

So far as known, the areas underlain by granitic rocks do not contain concentrations of commercially important minerals. The Keewatin belts, are, however, favourable grounds for prospecting, but the excessive amount of muskeg and glacial debris renders the search for mineral deposits rather difficult. In the past the attention of those interested in the development of this area has been largely confined to a search for ores of iron. As a result, portions of the iron range have been pretty thoroughly investigated, and large concentrations of iron have been proved, but the high sulphur content of the deposits militates against their immediate use as ores of iron. The discovery of lead, zinc, and copper mineralization has, however, awakened interest in the area, and although no ore-bodies of these metals of commercial size were exposed when the author visited the area, the surface indications are good, and seem to warrant additional investigation.

IRON DEPOSITS

Jefferson Claims

A block of claims, commonly known as the Jefferson claims, includes the greater part of the iron range east of Rush river. They are owned by the Jefferson Mining Company, of which Mr. W. E. Smith, of Smith and Rietz, barristers, Minneapolis, is the representative.[1] From Rush lake the claims can be reached by a trail that starts from a bay on the northwest side of the lake. The trail leads northwestward for a little over a mile, where it intersects the iron range, thence it follows the iron formations southwestward to Rush river, thereby affording an equally easy approach to the claims from the west.

These locations were staked by Mr. Smith in 1908, and, through his efforts, they have been fairly well tested for ores of iron. A considerable amount of stripping and test pitting has been done, and, in 1910, some 4,000 feet of diamond drilling further investigated the ore possibilities of these claims. The results obtained from this work have been discussed in some detail by Moore.[2] They prove the presence of large and persistent bodies of potential iron ores, but the excessive amount of sulphur, which is omnipresent, renders their immediate use, as ores of iron, unlikely.

The iron formations on which these claims are located consist of two members—one of which is a sedimentary, the other apparently a replacement, deposit. The sedimentary member is made up, essentially, of interbanded silica and iron carbonate or hematite, but locally the carbonate or hematite gives place to pyrite. Wherever the range has been subjected to severe contact metamorphism, the carbonate and hematite have been converted into magnetite, and in the eastern part, on claims W.D.717, 718, and S3693, pyrrhotite and magnetite are the dominant iron-bearing compounds interbanded with the silica. These siliceous deposits occur as discontinuous, overlapping, flat, lenses interlain by basic to intermediate tuffs and flows, and, on the whole, they are too lean to be considered of economic value.

The replacement deposits lie almost exclusively in the rhyolite, and greenstone schists immediately south of the banded silica. Commonly they abut and partly replace the siliceous member, but often they lie several feet south of the contact between the schists and the banded silica. Their boundaries are not well defined, but tend, rather, to fade gradually into unreplaced schists. On the western claims of the Jefferson group, these deposits are composed essentially of iron carbonate and pyrite, with which are associated small amounts of magnetite and pyrrhotite. Eastward, however, the magnetite increases markedly at the expense of the carbonate, and pyrrhotite becomes the dominant sulphide present. This change is probably due to the influence of the granitic intrusives that invade the eastern part of the range. These deposits are extensive and contain large concentrations of iron. Sulphides, however, are ubiquitously present, and locally they occur in such quantities as to constitute a low-grade sulphur ore.

[1] Moore, E. S.: 35th Ann. Rept., Ont. Dept. of Mines, pt. 2, p. 86 (1926).
[2] Moore, E. S.: Op. cit., pp. 90-94.

Assuming a minable depth of 100 feet, Moore estimated[1] that a total of 4,600,000 tons of ore minerals were present on these claims which would analyse 40 to 43 per cent metallic iron. This estimate seems quite warranted, and there is good reason to believe that the deposits will persist to much greater depths than that assumed, so that many more millions of tons may safely be added to the calculation of minable deposits of this type. But, as pointed out by Moore, their immediate value as ores of iron is doubtful. None of these deposits could be used without a preliminary treatment of roasting and sintering to rid them of the deleterious sulphur present, and the costs of such operations will in all probability place their utilization beyond the pale of present market conditions.

LEAD-ZINC AND COPPER

Claim W.D.717, Jefferson Group

In 1910 while drilling claim W.D.717 for ores of iron, streaks of sphalerite and galena and chalcopyrite were found in the cores taken from holes Nos. 2 and 3. Search was forthwith made for sizable deposits of these minerals, and a vein consisting chiefly of galena was discovered in a trench 360 feet east of the drill holes. In 1912, additional stripping was done, and a test pit, some 8 feet in depth, was sunk on the vein, and, in the spring of 1928, Messrs. Smith and Traverse, of Sudbury, further investigated the property by diamond drilling. Ten holes were driven at fairly close intervals, along the south side of the deposit. These are all ledged in the rhyolite tuff member of the Keewatin complex, and are dipped toward the north. The data obtained from a study of the drill cores are not at hand. The property is now under option to Canam Metals, Limited, Negaunee, Michigan, who are directing a further drilling campaign.

The excessive amount of glacial till that overlies the bedrock in this part of the area renders it difficult to determine the nature of the deposit except as it is exposed by stripping. The vein which bears the lead-zinc minerals is included for the most part in a chloritized schist which is profusely impregnated with pyrrhotite, pyrite, and magnetite, and lies directly south of the banded silica member of the iron formation. The vein is, therefore, in the replacement member of the iron range. Southward this pyritized band grades into a recognizable facies of the rhyolite tuff which at this locality has been converted by metamorphism into a garnet-bearing quartz-chlorite-actinolite schist. The schists trend north 70 degrees east and dip southward at a high angle. The vein strikes about north 65 degrees east. On the east margin of the pit it is 18 inches wide and composed almost entirely of galena, with much lesser amounts of sphalerite and a little pyrite. Ten feet east of this it is narrowed to 15 inches, but maintains its concentration of lead zinc ore minerals, and 40 feet farther east along the strike a width of 36 inches was measured, which though not so pure is still a high-grade ore, and carries, in addition to the galena and sphalerite, a considerable amount of chalcopyrite. Numerous small veinlets, composed essentially of sphalerite, permeate the wall-rock on either side at

[1]Moore, E. S.: op. cit.

angles upwards to 90 degrees from the trend of the vein. These are in many cases accompanied by a gangue of calcite, dolomite, and epidote, and in some cases, pink feldspar and quartz are present as gangue in these stringers. In a cross trench 112 feet east of the shaft the main vein does not appear, but 25 feet northward across the strike a number of veinlets of sphalerite occur which trend northeastward. These are probably tails from another vein system.

Slides made from the wall-rock of the vein are found to contain an abundance of fibrous green amphibole and talc in aggregates in the portions of the rock that are impregnated with sphalerite. Chlorite is also abundantly present. In many cases it is found replacing garnet, and in turn being replaced by the amphibole or talc. Magnetite occurs in large quantities both as well-formed euhedra and as fine dust-like reaction products. The sphalerite and galena seem to be late comers. They are in many cases present in little clusters and veins intergrown with each other, associated with a little calcite and siderite, and interlocked with aggregates of green amphibole.

Among the ore minerals, pyrrhotite distinctly replaces pyrite, and is in turn replaced by chalcopyrite, sphalerite, and galena. The relative age of the latter three minerals is not clear, but the galena is probably the younger. A second generation of pyrite seems to be present which veins and includes the others, and has seemingly been introduced along with the lead-zinc-copper minerals.

From the data at hand no reasonable surmise can be made with regard to the size of the ore-body present on this claim. The main deposit seems to be a fissure filling, and some evidence was amassed that suggests that the rocks at this part of the range have been caught in a sharp asymmetric fold, the axis of which trends approximately east-northeast across the southern boundary of the claim. It seems likely that the lead-zinc vein owes its location to a tendency on the part of the relatively competent iron formations to fracture and control the structure under deformational stress, thus providing favourable channels for the percolation of mineralizing solutions, and if the structural interpretation for this part of the area, as outlined above, be correct, then it is reasonable to expect other fissures to parallel this one or to persist eastward at angles a little north of the direction of the axis of folding. The presence of small stringers of sphalerite in the iron formation northeast of the main vein rather suggests that this is the case, whereas from the description given of drill holes 2 and 3, in which the lead-zinc minerals were first noted, it would appear that the ore minerals occurred in parallel streaks throughout a zone about 20 feet long.[1]

The author has had no analyses made of ores from this property. Moore, however, reports an analysis of a sample,[2] taken from the bottom of the shaft, which runs 73·44 per cent in lead; 6·01 per cent zinc; and no silver. No mention of copper is made in this result. A sample[3] taken from the surface outcrop, by Tanton, gave: lead 69·28 per cent; zinc 1·03 per cent; copper 1·25 per cent; and 1·32 ounces to the ton in silver.

[1]Moore, E. S.. "A Lead and Zinc Deposit in Keewatin Iron Formation"; Trans. Can. Inst. Min. and Met., vol. 29 (1926).
[2]Moore, E. S.: Op. cit., p. 94.
[3]Tanton, T. L.: Geol. Surv., Canada, Sum. Rept. 1916, p. 181.

Burton Claims

A block of claims lying north of the Jefferson property, in Genoa township, is owned by Mr. A. Burton of Sudbury. On one of these, claim S5991, a shaft, said to be 40 feet in depth, has been sunk in a shear zone about 250 feet north of the southern boundary of the claim. Highly schistified tuffs and flows of basic to intermediate composition underlie the greater part of this property. These strike north 72 degrees east and the dip is inclined at a high angle toward the south. A dyke of altered diabase trends approximately east-west across the claim 375 feet north of the shaft. This dyke is upwards of 150 feet wide, and 250 feet north of this another large dyke of similar character cuts the Keewatin schists trending a little south of west. Small sills of this rock intrude the schists near the shaft, and numerous quartz feldspar porphyry dykes are also present in the Keewatin schists, usually paralleling the diabase.

The material on the dump is made up of severely mashed and slickensided graphitic, chloritic, and talcose schists, together with some crushed vein quartz. Numerous small veinlets of calcite and epidote permeate these blocks, and, associated with calcite, in some of them, are small amounts of galena and sphalerite. The quartz contains some pyrite, and in some cases a little chalcopyrite is present.

A stripping 50 feet west of the shaft exposes a zone, about 16 feet wide, of highly sheared schists similar to the material on the dump. About 3 feet of this shear zone is composed of crushed quartz. Pyrite is present in some parts of the crushed portion, and small stringers of epidote, chlorite, and calcite carrying specks of galena and sphalerite are also present.

A channel sample taken over 3 feet of the better mineralized part of this shear-zone was assayed for values in gold and silver. It yielded 0·05 troy ounce per ton of silver, but gold was repted to be absent.[1]

Jessop Claims

In the spring of 1928 a number of claims were staked along the north shore of Rush lake by Mr. Jack Jessop of Sudbury. One of these embraces the narrow neck of land that separates the bay at the northeast end from the main body of the lake. A band of siliceous iron formation with a maximum width of 33 feet trends across this claim and approximately marks the boundary between the Keewatin schists on the north and a mass of intrusive granite on the south. The Keewatin rocks at this part are greatly disturbed by intrusions of quartz diorite and dykes of granite. The general trend is, however, about north 75 degrees west and the dip is southward at a high angle. Early in the summer of 1928, impregnations of sphalerite were discovered in the iron formation bluff on the south shore of the northeast bay, and stripping has revealed the presence of a fahlband 36 inches in width, in which sulphides of lead, zinc, and copper occur along with pyrite and magnetite. The mineralized zone is contained in the banded silica iron formation, and at the time the property was examined by the writer it had been followed along the strike for a

[1]Rivington, J. A.: Mines Branch, Analyst.

distance of about 150 feet. Throughout this distance the tenor of the deposit remained fairly constant. The sulphides do not comprise more than 10 per cent of the rock, but of these sphalerite is the most abundant. Assays made from samples of this deposit are said to have yielded values in silver and gold along with their copper-lead-zinc content.

MOLYBDENITE

On the west shore, just north of the narrows on Twin lake, a small body of water situated in the area east of Genoa township, a gneissose facies of granite occurs which contains abundant small gash veins of quartz and some molybdenite. The sulphide occurs as small flakes disseminated through the rock over a width of 25 feet. Two hundred feet inland from this point a pegmatitic dyke, averaging 16 inches in width, cuts the Keewatin schists. The dyke trends north 70 degrees east and may be traced along the strike for a distance of about 100 feet. The walls of the dyke are composed of pink feldspar, and vein quartz, averaging 7 inches in width, fills the centre. Molybdenite, in small flakes, is rather profusely scattered throughout the dyke, and the quartz contains some pyrite. A typical sample of this vein yielded on analysis a trace of gold and 0·36 troy ounces of silver per ton.[1] No assay was made for molybdenite, as in this outcrop it is obviously too low grade to be of any commercial value.

ASBESTOS

Small masses of altered peridotite occur in the volcanics west of Rush lake. One of these outcrops just north of milepost 5 on the boundary line between Genoa and Marion townships. This body was traced eastward as far as claim S3693—a distance of about ½ mile. Its maximum observed width was 125 feet. From its trend it is believed to be a sill, but its contacts with the adjacent rocks have not been seen. Another mass of similar rock occurs about 5 chains south of the McOwen-Genoa boundary at a point approximately 10 chains east of milepost 1. This mass is 50 feet wide and is exposed a distance of 80 feet along the strike. These rocks are easily distinguished from any other rocks in the area, because of the fact that their weathered surface is usually quite soft and talcy, and of white to creamy brown colour. The fresh surface is dark green, and made up, generally, of radial aggregates of serpentine. Small veinlets of asbestos fibre traverse the serpentinized portions of the rock, but no fibre of commercial grade was observed.

CHROMITE

Thin sections of the altered peridotite masses, described above, reveal the presence of small quantities of chromite in the serpentine, along with rather large amounts of fine-grained aureola of magnetite.

[1]Rivington, J. A.: Mines Branch, Analyst.

DESMELOIZES AREA, ABITIBI DISTRICT, QUEBEC

By J. B. Mawdsley

CONTENTS

Illustration

INTRODUCTION

During the field season of 1928 the Desmeloizes quadrangle and some adjacent territory immediately north were geologically mapped and the mineral deposits of economic interest within them were studied. When not engaged on other duties the writer worked with the two sub-parties respectively in charge of H. D. Squires and S. H. Ross, who ably carried out the field work. The assistants on these two parties were J. Satterly, H. S. Gerson, E. B. Papenfus, E. Monahan, E. F. Creelman, and R. E. Whiting. The work was advanced in many ways by the ready co-operation given by the staffs of the various mining and prospecting companies carrying on work in the area. This was especially true of the staffs of the Abana Mines, Limited; Demara Mines, Limited; Abbey Mines, Limited; and Altura Mines, Limited.

A good deal of the office work necessary for this report was done by J. Satterly.

LOCATION AND AREA

Desmeloizes map-area lies between latitudes 48° 45′ and 49° 00′ and longitudes 79° 00′ and 79° 30′. The west boundary is the Ontario-Quebec boundary and the south boundary intersects Abitibi lake at the Interprovincial Boundary. The map-area has an east-west length of 25 miles, a north-south width of 17 miles, and a total area of 425 square miles. The Canadian National railway runs southeasterly across the southern part of the area, from a point on the Ontario-Quebec boundary, 8 miles north of the southwest corner of the area to its southeast corner.

The adjoining area, which also was studied, has an area of approximately 50 square miles, and consists of a strip 8 miles wide east and west by 7 miles wide north and south, bounded on the west by the Interprovincial Boundary, and on the south by the north boundary of Desmeloizes map-area.

The area mapped includes the north halves of La Reine and La Sarre, the northwest quarter of Royal-Roussillon, all of Desmeloizes and Clermont, and the west half of Chazel township, as well as the 50 square miles north of these townships.

MEANS OF ACCESS

The area is easily reached by the main line of the Canadian National railway, which, as previously stated, traverses the southern part of the area. From the stations of La Reine, Dupuy, La Sarre, and Makamik, any point in the southern tier of townships can be easily reached from roads that are nearly all suitable, in dry weather, for automobile transportation. From the station of La Reine points in the western part of the township of Desmeloizes can be reached by roads extending as far north as range line VI-VII. From Dupuy a good road with east and west branches in Desmeloizes township 2½ miles from its east boundary, reaches range line II-III. From this point a good winter road, but a poor summer one, extends north for 7½ miles to the Abana mine in lot 43, range X, Desmeloizes township. From the Abana there is a fairly good wagon trail passing the Abbey property and extending to the Altura, 6 miles a little west of north of the Abana. Various trails and portages from this road reach the other properties in this part of the area. From La Sarre a north-south road running half a mile west of the centre lines of La Sarre and Clermont townships reaches range line II-III, Clermont township. From this point a fairly good wagon trail, 8 miles long, mostly over a sandplain, reaches Turgeon river in lot 38, on range line IX-X, Clermont township. From this road and trail traversing Clermont township, the various parts of the township can be reached along the east-west range lines which are at mile intervals.

Before the settlement of the area and the construction of the present road system the small and difficult streams, like the La Reine in western Desmeloizes township and the Calamity in the eastern part of the same township, were important routes into this part of the area, but they are now little used. The same is true of the much bigger and easily canoeable La Sarre river draining Royal-Roussillon lake in the southeast part of the area. This river flows westward along the north boundaries of Royal-Roussillon and La Sarre townships to a point 3½ miles from the west boundary of Royal-Roussillon township where it sharply turns south and flows in this direction to a point 2½ miles south of the south boundary of the map sheet where it empties into the east end of lake Abitibi.

Turgeon river, which is easily canoeable, drains Turgeon (Otter) lake. The southern bay of this 6-mile long lake is in the northeast corner of the map-area. The lake trends northwesterly and from its west end discharges into Turgeon river which follows a circuitous route, crossing the north boundary of Clermont township in the centre of lot 49, and crossing range line IX-X of this township in lot 39; from here it swings north and crosses the north boundary again in lot 34. From here for many miles it flows a little west of north.

From lake Turgeon (Otter) a poor canoe route can be followed southward up Ojima river, which flows into Turgeon lake from the southwest, then across to Chazel lake and south along Chazel river to La Sarre river $2\frac{1}{2}$ miles from the west boundary of Royal-Roussillon township. There are some long muskeg portages on this route which is the only one traversing this part of the area.

PREVIOUS WORK

Many geologists have traversed parts of the map-area during the last sixty years in the course of exploratory surveys that have covered a large adjacent area of Quebec and Ontario. The earliest of these workers was Walter McOuat[1] who in 1872 reached and examined geologically the shores of lake Abitibi. In 1906 and 1907, W. J. Wilson[2] carried out a geological reconnaissance along the line of the National Transcontinental railway in western Quebec. During the course of this work he traversed lake Makamik (Macamic) and La Sarre river, marked on his map as Amikitik river (amik means beaver in Ojibwa) and called in his report, page 16, Whitefish river. Calamity river is designated as such on his map, but the La Reine is called the Okikodasik. On this map, which is on a scale of 4 miles to 1 inch, is represented the southern part, 12 miles wide, of Desmeloizes map-area.

In 1906 J. Obalski[3] ascended La Sarre (Amikitik) river from Abitibi lake to the National Transcontinental railway. In the following year he again ascended La Sarre river to Makamik (Macamic) lake.[4]

In 1910 M. E. Wilson carried out a geological reconnaissance in the vicinity of lake Abitibi and included a strip of country forming the southern part of Desmeloizes map-area.[5] A map on the scale of 4 miles to the inch accompanies his memoir.

Tanton in 1914 and 1915 made a geological reconnaissance of the Harricanaw-Turgeon basin. A brief reference to this work was made in the summary reports for 1914 and 1915, pages 96-98 and pages 168-170 respectively. The final report was published as Memoir 109 [6]. A map accompanying this memoir, on a scale of 4 miles to 1 inch, includes the whole of the area mapped during the past summer and considerable additional territory to the north and east.

TOPOGRAPHICAL FEATURES

The topography of the area is typical of this part of the Canadian Shield. The maximum relief is relatively small, the difference of elevation between the lowest and highest point being approximately 430 feet. The lowest points are in the southwest corner and 13 miles farther east, on the shores of lake Abitibi and the banks of La Sarre river, the heights of which are 868·0 feet above sea-level. The highest elevation is a hill $6\frac{1}{2}$ miles north of the north boundary of Desmeloizes township and $4\frac{1}{2}$ miles east of the Ontario-Quebec boundary; it has an approximate eleva-

[1]McOuat, Walter: Geol. Surv., Canada, Rept. of Prog. 1872-73, pp. 125-126.
[2]Wilson, W. J.: Geol. Surv., Canada, Mem. 4 (1910).
[3]Obalski, J.: Mining Operations in the Province of Quebec, 1906, p. 22.
[4]Obalski, J.: Mining Operations in the Province of Quebec, 1907, pp. 50-52.
[5]Wilson, M. E.: Geol. Surv., Canada, Sum. Rept. 1911, pp. 203-207; Mem. 39 (1913).
[6]Tanton, T. L.: Geol. Surv., Canada, Mem. 109 (1919).

tion of 1,300 feet above sea-level. The local relief is much less and is from 30 to 150 feet. The higher features are, in most cases, rocky hills and ridges, although some are morainal hills, sand ridges, and clay-blanketed hills.

The highest section is in the extreme northwest, north of Desmeloizes township, and extends into range X of this township between lots 20 and 40, the southernmost tip extending to the centre of lot 43. The eastern boundary of this relatively high section trends a little east of north and crosses on the north boundary of Desmeloizes township about lot 45. The westward and northward extent of this section is not known. It is like the areas termed rocky uplands in adjacent parts of Quebec. The rest of the map-area is a clay-covered lowland of low relief from which project low hills of rock, moraine, sand, or of these materials covered with clay.

The rocky upland area has a general elevation of about 1,070 feet above sea-level and gradually rises towards the northeast. Some of the streams traversing it lie 30 or 40 feet below the general surface, and a few ridges rise 150 to 230 feet above it. A prominent ridge reaching a height of about 1,260 feet above sea-level starts on the Abana property in the centre of lot 43, range X, Desmeloizes township, and extends 30 degrees north of west for a distance of 1½ miles, with a width of about three-quarters of a mile. Immediately northeast of Calamity lake, 4¼ miles north of the north boundary of Desmeloizes township and 6 miles east of the Ontario-Quebec boundary, is a nearly flat area, 1½ miles in diameter and about 100 feet above the adjacent country. A mile and a half north and northwest of Calamity lake is an area trending northwest, 1½ miles wide and 2½ miles long, relatively flat, and somewhat higher about 1,200 feet above sea-level than the country to the south. A mile farther northwest, at the northern margin of the area mapped, a hill three-quarters of a mile in diameter and which, as previously mentioned, is the highest point in the area, rises to about 1,300 feet above sea-level. To the west and southwest of this hill there are prominent ridges, which rise to over 1,200 feet above sea-level and as much as 250 feet above the adjacent country.

All the rest of the mapped area, that is, practically all the Desmeloizes quadrangle, is a clay-covered lowland area forming a part of the clay belt region of northern Ontario and Quebec. This lowland within the map-area ranges in elevation from about 880 to 1,000 feet above sea-level and probably averages about 930 feet above sea-level. This plain is somewhat higher in the north than towards the south. It is broken here and there by low hills, ridges, and areas of rock, moraine sand, and by rounded, clay-covered knolls. Most of these hills do not rise more than 20 or 30 feet above the general level, but a few are 60 or more feet high. The low, rocky hills are for the most part confined to certain sections separated by areas of no rock outcrop. An area of about 15 square miles of low, rocky, and morainal hills lies in the southeastern section of the township of La Reine.

Many of the rocky hills have morainal margins and morainal hills are scattered throughout the area. A sand and moraine area in central Clermont township lies one mile east of the centre line of the township and extends for about 6 miles in a north-south direction between range IV and range IX, with an average width of one mile. The relief is up to 100 feet and the deeper depressions contain small ponds. In range VII and the south part of range VIII, a smoothly curving ridge of sorted morainal material extends for 2 miles northwestward from the previously described area.

The rounded clay hills are numerous, but are not as prominent as those of other materials and probably none rises higher than about 1,000 feet above sea-level.

The drainage pattern of the area mapped is quite irregular. A few of the smaller streams head in the northern rocky upland area. The small streams in the low, clay area flow in nearly all directions and empty into three larger streams, parts of whose courses lie within the map-area.

Streams draining west, south, and north have their sources in the rocky upland area north of Desmeloizes township. The largest of the western flowing streams is Patten creek which drains northwestward into lake Bill on the Ontario-Quebec boundary. The most important of the south-flowing streams is the Calamity which flows south and then southeastward into the low country to the southeast. Roughly paralleling Calamity river and from $\frac{3}{4}$ to 3 miles east of it, is the north-flowing Pajegasque river whose source is a muskeg on the north boundary of Desmeloizes township at lot 55. This muskeg is $\frac{3}{4}$ of a mile east of Calamity river 5 miles south of its source.

All the streams of the rocky upland area flow in irregular courses, partly through bouldery sections partly between steep banks of sand or moraine. Their gradient is usually considerable and probably from 20 to 40 feet to the mile.

Within a radius of $2\frac{1}{2}$ miles of Calamity lake are five small lakes, none of which, nor Calamity lake, is more than three-quarters of a mile long. Four of these lakes have rocky shores, the fifth has muskeg shores.

In the clay-covered lowland area the gradient of the streams is much less. Three fairly large streams partly lie within the map-area. In the west, La Reine river enters the townships of Desmeloizes and La Sarre for short distances. On the north, Turgeon river flows through the area for about 3 miles in the north part of Clermont township. In the southeastern part of the map-area, La Sarre river, which drains Makamik lake, flows for some miles near the north boundaries of Royal-Roussillon and La Sarre townships, turns abruptly south, and empties into lake Abitibi 3 miles south of the south boundary of the map-area.

These three rivers have smoothly sinuous courses and have entrenched themselves 10 to 30 feet below the level of the country. They are made up of quiet stretches separated by rapids or low falls where boulder moraine or bedrock occur in their beds. The gradients of the quiet stretches are very low, about 0·1 to 0·15 foot per mile. La Reine and La Sarre rivers drop 0·6 foot in distances of 4 and 7 miles respectively from the railway to lake Abitibi. The only drops important from a power point of view, along any of these rivers within the area, occur on La Sarre river, north of the railway. These drops from east to west are of, respectively, 4, 24, 10, and 8 feet. The possible minimum power development on the 24-foot drop, in lot 43, range IX, La Sarre township, is estimated by the Dominion Water Power and Reclamation Service to be 350 horsepower and for an ordinary six months flow, 945 horsepower.

The smaller streams, also, have low gradients and since their channels are cut through clay they have, for the most part, meandering courses along which cut-offs and oxbows are common.

Parts of three large lakes lie within the area. At the southwest corner a bay on the north shore of lake Abitibi extends into the area. The west half of Makamik lake lies in the southeast corner of the area. This shallow lake is about 4 miles in diameter and has shores of a varied nature, either rocky, muskeggy, or wave-cut cliffs of banded clay as high as 10 to 15 feet. In the northeast corner of the map-area is the south part of the third lake, lake Turgeon, whose total length in a northwest direction is about 6 miles and whose width is ½ to 2½ miles. The shores of the part of the lake lying within the map-area vary, are in part rocky, in part of muskeg. The few other lakes within the area are small. A shallow lake with grassy shores, three-quarters of a mile long, occurs on the Desmeloizes-Clermont boundary on range line IX-X. Three miles to the east is another lake of similar character and size. In range III, Chazel township, 2 miles from its west boundary, is an irregular-shaped lake 1½ miles long whose shores are mostly rocky or of moraine. Just north of lake Makamik are two small lakes separated by muskeg from one another and from lake Makamik of which they once formed a bay. A lake with muskeg shores, 1½ miles long, occurs in ranges IV and V, La Sarre township, a mile from its west boundary. A few small ponds, for the most part surrounded by muskeg, occur in other parts. In the sandy area in central Clermont township are some small pot-hole lakes or ponds. These small bodies of water have steep shores as much as 100 feet high and most of them have no outlets.

Open muskegs are not numerous. None of the few present is more than a mile wide. They were once shallow lakes now filled with decayed vegetable material and overgrown with sphagnum moss. Sparse growths of tamarack and spruce found here and there, grow on similar deposits of decayed vegetable matter. Ditching along some of the roads indicates depths of 3 to 8 feet of this material.

GENERAL GEOLOGY

INTRODUCTION

The map-area is largely underlain by a volcanic assemblage such as has been classed as Keewatin in adjacent districts to the south and east and in other parts of eastern Canada. The volcanics are predominantly flows of intermediate composition such as andesites, but flows of more acid or basic composition are common. A considerable area of acid rhyolite flows is present over an area north of the north boundary of Desmeloizes township. Interbedded with the flow rocks are small amounts of volcanic breccia, tuff, iron formation, and of sediments which, in many instances.

have the characteristics of normal waterlain detrital material. Larger developments of these last-mentioned rocks have been mapped separately. With the typical flows may very possibly be associated intrusive sills and dykes similar in composition to the volcanics and whose intrusive character has not been recognized. The intrusives, if they occur, may be of different ages, some may be of Keewatin age and related to the volcanics, others may be younger and may represent the so-called older gabbros as differentiated on maps of other parts of Quebec.

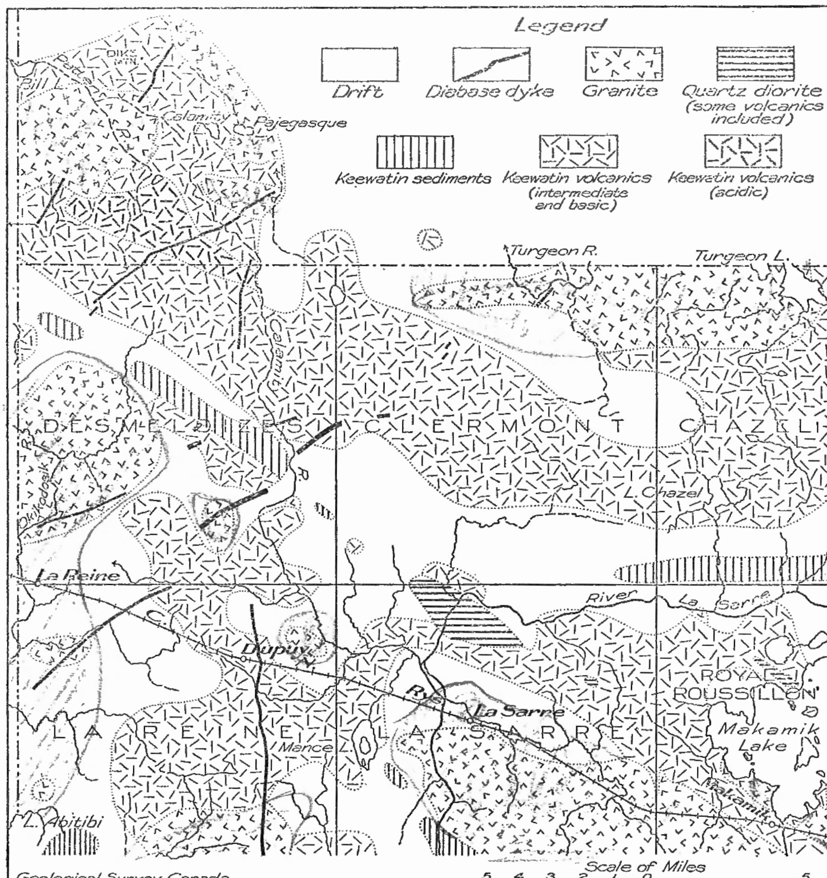


Figure 2. Sketch map of geology of Desmeloizes map-area.

The volcanics are the oldest rocks recognized. They are intruded by granitic bodies and by still younger diabase dykes. The presence somewhere of an older granitic intrusive seems indicated by granitic pebbles seen in a narrow conglomerate band lying between volcanic flows on the Abonde property.

KEEWATIN VOLCANICS

The usually highly altered volcanic flows have been arbitrarily grouped as acidic, and intermediate and basic. The acidic volcanics are largely rhyolites and acid porphyries; the intermediate and basic flows are, or approach, andesite or basalt in composition. Two ill-defined zones of carbonated and sheared volcanics of various composition, chiefly rhyolites and acid andesites, form belts 1 to 2 miles wide and corresponding in strike to the volcanics. One of these belts extends from just north of the northwest corner of Desmeloizes township, east-southeast across the north part of this township to its eastern border. The other belt strikes east and lies in southwestern Chazel township.

Rhyolites and Acid Porphyries

The chief development of these rocks lies just north of Desmeloizes township, but extends southeasterly into the township. The acidic rocks here underlie 90 per cent of a triangular area having a maximum width of 2¼ miles (*See* Figure 2). In the poorly exposed area of western Chazel the rhyolites form an appreciable percentage of the volcanic rock outcrops. In central and southern Clermont and in northeastern Desmeloizes they are also present but form a much smaller proportion of the volcanic assemblage there exposed. In the southern part of the map-area they are practically absent.

Banding, and flow textures and flow structures were not recognized, nor were individual flows distinguishable in the areas where the acidic rocks predominate. This was due, probably, in part, to the sheared condition of the rocks, but since in the more basic volcanics, structures are recognizable after shearing, it is probable that the acidic rocks had not well-developed flow structures.

The rhyolites and acid porphyries vary considerably in colour and texture, the rocks grade from aphanitic to porphyritic, and light cream, light greenish grey, light and dark grey are common tints and shades. Sheared phases predominate and, for the most part, are light in colour and many have a satin-like appearance due to the secondary minerals developed. The carbonated types are buff or pinkish brown.

A massive, aphanitic type was found near the west boundary of Clermont township in range X. Elsewhere the aphanitic types were more or less sheared and closely resembled the fine-grained groundmass of the porphyritic types.

The porphyries are quartz porphyries, and quartz-feldspar porphyries. Some have only quartz phenocrysts, but most have at least a few feldspar phenocrysts and in some cases 50 per cent of the phenocrysts are feldspar. Such a high percentage is not common, however, probably because in the shearing and alteration of these rocks the feldspars have suffered granulation and alteration to a greater extent than the quartz phenocrysts.

The quartz phenocrysts vary in size from ½ mm. to 3 mm. They are usually round or lens-like in outline, with finely crenulated borders due probably to crushing and recrystallization of the margins and adjacent groundmass. The quartz phenocrysts of the rhyolite in the area north of Desmeloizes township are, predominantly, of a striking, opalescent blue colour and, in thin sections, were seen to be filled with minute crystals of other minerals and with minute cavities, some of the larger of which displayed bubbles. The colour is probably due to these dust-like inclusions. The opalescent quartz resembles closely the quartz in some of the adjacent granites. The shearing which the rock has suffered, strained and in many cases shattered the quartz, thus producing an augen structure, white mica surrounding the quartz grains. The feldspar phenocrysts are of the same sizes as those of quartz and have much the same shapes and borders, though they tend to be more lath-like in form and in many cases occur in nest-like aggregates. The feldspar phenocrysts, in the fresh rocks examined, are albite-oligoclase and show little alteration to white mica. Where crushing has been intense a large quantity of white mica has developed and it is difficult to distinguish crushed phenocrysts from the adjacent groundmass.

The groundmass of these rocks is generally uniform and fine in grain, averaging about 0·02 millimetre. Owing to the small grain and the alteration products present it is exceedingly difficult to determine the relative amounts of quartz and feldspar, which undoubtedly vary in wide ranges, between 80 per cent quartz and 20 per cent feldspar and vice versa. The untwinned grains of feldspar have an index close to Canada balsam and are believed to be oligoclase-albite similar in composition to the phenocrysts. In the sheared rocks the groundmass shows considerable white, flaky mica in bands and stringers in a quartzose groundmass. The mica has, apparently, developed at the expense of the feldspar.

In some of these rocks appreciable percentages, in some cases 15 per cent, of chlorite and carbonate, are present. The chlorite is of at least two types, penninite and clinochlore. Zoisite commonly forms 5 per cent of the rock volume; iron ore and epidote occur in smaller quantities. Biotite is present in some sections, especially of rocks from near granitic contacts and in many cases is partly altered to chlorite. The biotite is probably secondary. Stumpy prisms and heart-shaped twins of rutile are abundant in some examples of the rocks. Colourless garnets were seen in some of these rocks.

Intermediate and Basic Volcanics

The volcanics of intermediate or basic composition greatly predominate over the acidic types which, as already stated, are mainly confined to a few areas and are almost wholly absent from the southern part of the map-area.

The intermediate and basic volcanics vary in colour from light green to almost black. In some of the unsheared areas the attitude of the flows is recognizable from a study of their flow textures and structures. Some of the rocks are porphyritic, but most are more or less even-grained and form flows which are individually of even grain ranging from fine to quite coarse. The structures recognized were amygdules, pillows, banding, segregations, and ropy and scoriaceous tops. Good examples of these various structures were seen.

Porphyritic types are not at all numerous. A few outcrops of dark coloured, pillowed, porphyritic volcanics were seen in which the feldspar phenocrysts were not more than 3 millimetres in diameter and lay in a dark green groundmass. A porphyritic type with large feldspar phenocrysts was seen in four localities. In this type the phenocrysts form 10 to 30 per cent of the rock volume, vary in size from 3 to 40 millimetres, are more or less rounded, and stand out on weathered outcrops, where they appear like white pebbles lying in a dark green matrix. When broken the phenocrysts show a hackly fracture and are a dirty yellow white. In thin section they are seen to be completely replaced by an extremely fine aggregate of zoisite and white mica with a little epidote, the zoisite being in the greatest quantity. The groundmass was studied in one thin section and there had a grain of about 0·1 mm. and was an allotriomorphic aggregate of about 50 per cent fresh, pleochroic, blue-green to yellow hornblende, 40 per cent fresh, twinned, and untwinned andesine (An_{40}), 10 per cent quartz, and minor amounts of iron ore, epidote, and zoisite. This thin section was of a rock that occurs half a mile north of the edge of the La Sarre granodiorite and it may be that the extremely fresh nature of the groundmass is due to recrystallization, but this seems unlikely as the phenocrysts do not seem to have been recrystallized.

The four localities where the porphyritic type with the large phenocrysts were seen are as follows: two outcrops 1¼ miles north of the north boundary of Desmeloizes township and, respectively, ¾ and 2 miles east of the Ontario-Quebec boundary; lot 17, range line IX-X, Desmeloizes township; lot 8, range line VII-VIII, La Sarre township; and a series of poorly exposed outcrops occurring for 6 miles in a west-northwest direction parallel with the strike of the volcanics, from the south part of lot 25, range IX, to the north part of lot 60, range V, La Sarre township. The two series of outcrops of porphyrite in La Sarre township may belong to one horizon in the volcanics and the courses followed by them may indicate the swinging of these flow rocks about the La Sarre granite mass.

The non-porphyritic, intermediate to basic rocks vary in texture even within the same flow, the contacts being, in many cases, finer grained than the central parts. Within the limits of single outcrops the texture may vary from fine to coarse grained. The finer-grained varieties in some cases show a diabasic texture, but this is not common. The coarse varieties have an equigranular texture, up to 1 centimetre in grain, and the coarser of these hold a high percentage of hornblende and might be termed amphibolites.

All these rocks are highly altered and if fresh-looking minerals are present it is believed they are secondary even in the case of fresh feldspar which, it is thought, probably is a recrystallized form of original plagioclase feldspar. Fresh plagioclase is rare, the mineral in most cases having altered to zoisite and white mica. The fresh feldspar approximates basic andesine in composition. Another mineral which, like the fresh feldspar, might not be secondary, is the hornblende seen in the coarse amphibolitic varieties. This hornblende in thin section is pleochroic, pale green, pale blue-green to nearly colourless, and occurs in stumpy, corroded crystals with ragged ends. It resembles closely the hornblende seen in the finer-grained rock varieties and which there occurs in feathery crystals definitely believed to be secondary.

The original compositions of these non-porphyritic rocks are not determinable, but in all probability they were andesites and more basic forms ranging to and including basalts or gabbros. They are now composed essentially of hornblende in amounts varying from 50 per cent to 75 per cent of the rock volume, zoisite and epidote varying from 10 per cent to 45 per cent. Quartz as a rule is absent or low in amount, but in some coarse varieties it forms to as much as 30 per cent of the volume. Feldspar was not seen to form more than 10 per cent of these rocks and it is basic andesine in composition. In a few sections a little chlorite was seen either in aggregates in the groundmass or secondary after hornblende. In one section a little green biotite was seen. Small amounts of the accessory minerals, magnetite, sphene, and rutile, occur.

A somewhat different type of the non-porphyritic volcanics was seen within a few feet of the edge of the Patten granite mass north of Desmeloizes township. It probably is a more highly metamorphosed phase of the massive volcanic rocks. It is dark, fine-grained (0·04 millimetre), quite fresh. The approximate composition is: quartz 60 per cent, biotite 20 per cent, hornblende 15 per cent, zoisite and epidote 5 per cent, and a few grains of feldspar and the accessory minerals, apatite, titanite, and magnetite. The biotite is perfectly fresh and occurs in part in stumpy, lath-shaped forms. The hornblende is the usual blue-green to yellow, pleochroic variety and it occurs in grains and poorly formed stumpy crystals. The zoisite and epidote occur in scattered grains and along zones. The magnetite grains are seen in hand specimens to be surrounded by white aureoles, $\frac{1}{4}$ millimetre in diameter, consisting of grains of quartz. Rims of titanite surround magnetite grains.

Metamorphism of the Volcanics

The alteration of the volcanics has apparently resulted in the development of secondary hornblende, occasionally biotite, epidote, and zoisite, and, in places, much quartz. The almost complete absence of chlorite, contrasted with its abundance in the volcanics of districts to the south and east, is notable. It probably indicates that the volcanics have suffered more severe contact metamorphism than rocks to the south and east. There is no clear evidence that the volcanics in Desmeloizes map-area were not chloritized previous to the intrusion of most of the granitic masses. It may have been that chlorite once was abundant and that as a result of metamorphism produced by the granitic bodies, the chlorite was transformed into some of the minerals now found in these rocks.

KEEWATIN SEDIMENTS

Wide sedimentary bands occur in the area, their trend conforming closely to the structures of the volcanic. Narrow sedimentary and tuffaceous bands occur interbedded with the volcanic flows at many points throughout the district.

A poorly exposed band of sediments at least 12 miles long and probably averaging $\frac{3}{4}$ mile wide, trends 33 degrees south of east from range IX on the west boundary of Desmeloizes township to range III on the east boundary of this township. On the strike of this band, to the southeast, in Clermont, La Sarre, and Royal-Roussillon townships, are bands of sediments interbedded with volcanics and this interbedded group is, probably, the continuation of the sedimentary band. Still farther southeast this interbedded zone seems to merge into the Privat band of sediments found by Buffam to extend for 25 miles to the southeast of the Desmeloizes map-area. The rocks composing the band in Desmeloizes township are for the most part dark, and approach slates in composition. Some may be altered, waterlain tuffs. The widest part of the band is largely composed of banded sediments, the bands varying in width in different outcrops. In some of the outcrops the bands vary in width from $\frac{1}{8}$ inch to 6 inches and in others from 1 foot to 2 feet. The bands are alternately slate and greywacke or impure quartzite. There are also present, throughout the band, minor amounts of volcanics of intermediate composition. In the southeastern part of the band the volcanics greatly predominate and the sediments vary considerably in composition. Most of them are finely banded and in large part are probably waterlain tuffs. Most of the bands are slaty or quartzitic. Other recognizable bands are either squeezed volcanic fragmental rocks or are conglomerates formed from volcanic rocks. The fragments or pebbles in these rocks are lens-like due to pressure and many are as much as 4 inches long and only $\frac{1}{3}$ inch wide.

A band of sediments striking east is exposed for $5\frac{1}{2}$ miles in widely separated outcrops, from lot 59, range I, Clermont township, to the east edge of the map-area. The greatest exposed width is $\frac{1}{2}$ mile. These sediments are strongly sheared parallel to the bedding which strikes parallel with the trend of the band. The dip is vertical. North and south of this band are drift-covered areas a mile wide separating it from outcrops of volcanics. On the strike of this sedimentary band to the west is an extensive drift-covered area. To the eastward the band is known to extend into eastern Chazel township where its exposed width is reported to be considerably greater than that found within the map-area. The sediments of this band are dark and banded. The bands vary in width from a fraction of an inch to as much as 2 feet. They are predominately slate bands interbedded with minor amounts of impure quartzite or greywacke bands. A few small outcrops of what might be sheared basic tuff or sheared and carbonated volcanics were found.

In the extreme southwest corner of the map-area, in lots 9, 12, 13, and 14, on range line II-III, La Reine township, are two outcrops of dark, fine-grained, thinly-bedded tuffs folded, crenulated, and cut by narrow veins of milky white quartz. The strike of these bedded rocks is north 45 degrees east and their dip is vertical. The axial planes of the highly contorted folds in these outcrops trend north and dip 60 degrees east.

Along the south edge of the map-area, in lot 18, range III, and lots 12 and 13, on range line IV-V, La Sarre township, are outcrops of highly altered banded rocks. In the northernmost outcrop they strike north 50 degrees west and dip 75 degrees northeast. The rocks in these outcrops are sheared parallel to the strike of the bedding, but the shear planes dip at a somewhat steeper angle to the northeast. Five miles farther to the northwest, along the strike of these sediments, sedimentary bands interbedded with the volcanics occur in the vicinity of Dupuy village. One of these bands has a probable width of about 800 feet, the others are much narrower. These rocks vary from green, tuffaceous rocks to impure quartzites in which mica has been developed owing to the metamorphic action of the granitic intrusive that outcrops a mile northeast of the village. For 5 miles northwesterly beyond Dupuy village, as far as lot 26, range line II-III, Desmeloizes township, sedimentary bands are present. One of these bands is 500 feet wide, but most of them are only a few feet or tens of feet in width. Most of the sedimentary rocks in this part are dark in colour due to the development of secondary hornblende. Some of them hold hornblende and chlorite or mica. These rocks, in places, are fine banded. They apparently were fine-grained, basic tuffs with some impure quartzite phases. Typical slates are notably absent.

Sediments varying considerably in nature occur in other places interbedded with volcanics. Typical volcanic agglomerates usually composed of one kind of volcanic material, the fragments angular and in many cases many inches long, occur in thin beds between flows, in many parts of the area. Coarse and fine sediments, usually showing banding and definitely waterlain, are also common and occur with breadths of from a few feet to a few tens of feet and to, very rarely, over a hundred feet. These waterlain sediments are conglomerates, quartzites, slates, and dark, banded rocks which are probably waterlain tuffs. Siliceous iron formation with a little associated fine sediments is also interbedded with volcanic flows. These various sedimentary phases probably form not more than 5 per cent of the total volcanic assemblage. The following are a few of the most important or interesting of these sedimentary areas.

Within the area of rhyolites 3 miles east of the Ontario-Quebec boundary and $1\frac{1}{2}$ miles north of the north boundary of Desmeloizes township, is an area underlain with dark slates and banded, impure, micaceous quartzite and arkose. The exposed length of this area is 1,500 feet east and west and 300 feet wide. The banding shows some contortion, drag-folds are present. The rocks are strongly sheared, a slaty cleavage being well developed. The strike of the bedding is, in most places, 17 degrees south of east and the dip, 80 degrees north. The shearing strikes 7 degrees south of east and dips 80 degrees south. The bedding shows no displacement along the shearing planes. Narrow, sinuous, quartz veins traverse the banded sediments and cut the shearing. The southern limbs of the crenulations of the veins usually parallel the planes of schistosity.

On the north half of lot 45, range IX, Desmeloizes township, on the property of the Abonde Mines, Limited, are a few narrow sedimentary bands within massive andesite volcanics. These bands are fine-grained tuffs, iron formation, and conglomerate. The most interesting band was a conglomerate bed 5 feet wide, which was traced for a couple of hundred feet along its strike. The strike is about 110 degrees, the dip, vertical. The conglomerate contains pebbles up to 4 inches in diameter; they show some squeezing and nearly all are pebbles of various kinds of volcanics. Three pebbles of granite were noticed. A thin section of one of these pebbles showed it to be a granite having a grain of 0·5 to 2 millimetres and composed of 70 per cent albite (An_8), 25 per cent quartz, and 5 per cent hornblende. The albite shows a tendency to a euhedral form and is altered in spots to white mica, epidote, and zoisite which form 5 to 40 per cent of the individual crystals. The opalescent quartz is interstitial. The hornblende is in crystals with ragged ends, and is pleochroic from dark green to yellow-green. A little titanite, apatite, and chlorite are also present in the rock. The granite of this pebble, since it contains hornblende, somewhat resembles the granodiorite bodies in La Sarre and Desmeloizes townships, but differs from them in not holding microcline. The pebbles have been derived from a granite not recognized or not present in the area. This granite must be older than the conglomerate and the adjacent volcanics, and, therefore, may be pre-Keewatin. It must be older than at least part of the Keewatin as now recognized in this part of Quebec.

In the vicinity of Chazel lake in Chazel township, are a number of outcrops of strongly sheared rocks. These lie from 2 to 3 miles north of the band of sediments in Chazel township, previously described. They extend from the central part of range III to the central part of range IV and have a possible width of 1 mile. Some of these rocks are undoubtedly strongly sheared and carbonated volcanic flows of acid and intermediate compositions. The sheared but uncarbonated rocks carry considerable white mica or chlorite and those rich in white mica have a satin-like look on a cleavage face. Sedimentary rocks are exposed best on the northeast shore of Chazel lake in range IV and in lots 26-27, range line III-IV, and lot 22, range line II-III, Chazel township, and there are almost wholly black slates. Carbonated phases are present and on weathered outcrops are rusty owing to the iron content of the carbonate. The carbonate is believed to be secondary and to have come in with mineralizing solutions which probably also brought the pyrite found in these rocks. Tanton[1] described in detail the outcrops at the northeast end of Chazel lake. He noted that the strike of the shearing changed rapidly from north to south within a distance of 900 feet. For most of the distance the strike varies from 65 degrees to 85 degrees west of north and the dip is vertical. Near the south end of the outcrops the strike is 20 degrees west of north and the dip still vertical. At the very south end of the outcrop the schistosity is 67 degrees west of north and the dip vertical, the bedding here strikes 70 degrees west of north and is vertical. What appeared to be bedding was seen in the slates forming the outcrop in lot 22, range line II-III, and they have a strike of 90 degrees and dip of 76 degrees to the north. Shearing here is at a slight angle to the bedding and has a strike of 5 degrees south of east and a vertical dip. In this outcrop a few quartz calcite veins were noted. It is certain that the altered sediments are interbedded with the volcanics. Their strike and dip correspond closely to those of the sediments in the band 2 miles to the south. It may be that the rocks to the north form the marginal sedimentary band to the south. If this is the case, the sedimentary band and included volcanics have a width at the east boundary of the map-area of 3 miles.

[1] Tanton, T. L.: Geol. Surv., Canada, Mem. 109, pp. 31-33.

Petrography of the Sediments

Quartzites. The quartzites and what appear to be impure quartzites are grey and where carbonated weather brown. Biotite is usually present and discernible in hand specimens. The grain varies from place to place and within the same specimen, from about 0·02 to 0·3 millimetre. Quartz usually forms from 50 to 80 per cent of the rock. It occurs in irregular grains, the larger of which, in many cases, definitely appear to be original, but many of the smaller grains may be products of recrystallization. Feldspar is in many cases present in fresh grains and is difficult to distinguish from the quartz grains. Usually it is in small quantities, but it probably forms as much as 30 per cent of some rocks. In some thin sections it has been found to be albite. Its usual fresh character is believed to indicate that the feldspar has suffered recrystallization. Biotite occurs in nearly all these rocks and commonly forms 10 per cent of the volume. It occurs in irregular-shaped flakes usually irregularly scattered through the rock, but in many cases lying along planes of shearing. White mica flakes of small size are very generally present. Green chlorite in irregular flakes is less commonly present. In one rock composed of 50 per cent quartz, 35 per cent carbonate, 5 per cent ilmenite, chlorite formed 10 per cent of the rock. Magnetite, ilmenite, titanite, calcite, pyrite, rutile, tourmaline, apatite, and zircon were noticed, but not all in any one thin section. A small amount of zoisite was found in one specimen.

The irregular distribution and the generally large amount of alteration products present in many of these rocks gives them a very confused appearance in thin section. This is heightened by the presence of introduced quartz and carbonate, often in the form of veinlets.

Slates. The slates are grey or, less commonly, brownish, and in many respects closely resemble fine, tuffaceous rocks with which, in many cases, they are probably closely allied in origin. They show a marked cleavage, are very fine grained, and where the composing minerals could be identified they were found to be similar to those in the fine-grained tuffs. Quantitative determination of the mineral content was impossible.

The banded rocks, which form a large proportion of the typical waterlain sediments found in the area, have bands varying in width from one-sixteenth inch to a couple of feet. The light-coloured bands are composed of quartzite usually impure, and the dark bands are slate or are similar in colour and composition to the green tuffs. The quartzite bands are usually the widest.

Tuffs. Fine-grained rocks usually green in colour and similar in composition to volcanics of intermediate or andesitic composition are termed tuffs in this report, for it is believed that most of them, at least, are true tuffs, though much that appears to be tuffs is probably waterlain sediments derived from the rapid erosion of flows and other volcanic material. The alterations in composition and the shearing that the rocks have undergone make it impossible to differentiate between these two types of sediments.

The fine-grained sediments, termed tuffs, are usually dark green, but some are quite light-coloured. Practically all are highly sheared and this structure seems to be more commonly displayed by these finer-grained rocks than by the coarse, volcanic fragmentals. Some of the highly sheared, so-called tuffs, may have been coarse, fragmental rocks or even flows whose original characteristics have been obliterated by shearing and igneous metamorphism.

The tuffs seen under the microscope are composed of varying quantities of very fine-grained quartz, chlorite, and white mica with small amounts of carbonate, feldspar, epidote, zoisite, biotite, and the accessory minerals, magnetite, pyrite, rutile, and tourmaline. The green colour is due to the high chlorite content. The light-coloured tuffs, which have a satin-like look on cleavage planes, owe their colour to their high white mica content and to the relatively small amounts of such dark-coloured minerals as chlorite.

The tuffaceous rocks in many cases show narrow banding which, probably, is due in most cases to the rocks having been waterlain. The tuffs vary considerably and grade imperceptibly into typical slates, impure quartzites, and banded rocks composed of these two rock types.

Near some of the igneous masses minerals like hornblende, garnet, biotite, and white mica are developed in large quantities. North of Desmeloizes township, near the east contact of a granodiorite mass, garnets form as much as 40 per cent of beds that were coarse fragmental or fairly fine tuff. Fine-grained hornblende schists, usually carrying biotite and showing fine banding, are believed to be metamorphosed tuffaceous rocks. A considerable development of such rocks was seen in southwestern Desmeloizes township and they are probably close to the edge of the body of granitic rocks outcropping in this part of the area.

Volcanic Fragmental Rocks. The coarse, fragmental volcanic rocks, or coarse tuffs, hold angular fragments of varying size up to 8 inches or a foot in length, but most of them are of the smaller sizes, fragments 1 to 2 inches long being common. The fragments are of volcanics that usually are similar to those with which the fragmental rocks are interbedded, but this is by no means always the case. Many fragmental rocks in areas of fairly basic volcanics are rhyolitic in composition. The fragments in any one bed are, in most but not all cases, of the same volcanic rock type. The matrix of the fragmental rocks is, in most instances, darker and more basic than the enclosed fragments. True bedding is not usually present. As a rule, the fragments have been elongated in the direction of the shearing that most of these rocks have undergone.

The coarse, fragmental volcanics grade imperceptibly, on the one hand, into rocks that contain pebbles rounded by water action and that are true waterlain conglomerates, and, on the other hand, into volcanic agglomerates composed of fragments of volcanic material embedded in a matrix which at the time of formation was a molten flow. This last-mentioned type is usually basic. An exceptional rock type is a pumiceous rhyolite fragmental composed of angular fragments ½ inch to 6 inches in length, embedded in a dark green groundmass. This was found 3¼ miles north of the north boundary of lot 38, range X, Desmeloizes township.

Iron Formation

Iron formation was seen in two localities north of Desmeloizes township on survey claims A19077 and A19073, 1½ mile west of Calamity lake; and 2 miles southeast, on the line between surveyed claims A25340 and A25335, ¾ mile south of Calamity lake. Local magnetic attraction, probably due to iron formation, was noticed on adjacent claims. Two and a quarter miles farther east-southeast, in a drift-covered area 2¼ miles north of the north boundary of lot 54, range X, Desmeloizes township, local magnetic attraction very probably indicates the presence of iron formation. The iron formation of the three localities probably belongs to one horizon.

The iron formation of the northern occurrence is closely crenulated. A fairly well exposed section on claim A19073 displays 77 feet of sediments lying between two andesitic flows. The succession from east to west is:

	Feet
Banded iron formation	20
Banded, dark green, epidotized, tuffaceous material probably mostly fine-grained hornblende and chlorite	4
Garnetized sediments, 80 per cent garnets and the rest fine-grained hornblende and chlorite	1
Conglomerate composed of angular fragments. The largest fragments are 8 inches by 3 inches. Most of the fragments are of sugary, white quartz similar to that in the banded iron formation. A few andesitic fragments are present	27
Poorly banded iron formation	5
Dark green rock containing 10 to 40 per cent of garnets; probably an altered, fine-grained tuff	16
Fragmental rock composed of lenticular fragments up to 3 inches by ½ inch in size, of acid composition, probably rhyolite. This rock contains 25 per cent of garnets	4

In Desmeloizes township a zone of iron formation indicated by intermittent outcrops and by magnetometer and dip needle surveys, extends from lot 45, range line VII-VIII, to just north of the north boundary of lot 26, range X.

Trenching, stripping, and magnetometer surveys on the Demara property in Desmeloizes township traced a band of iron formation interbedded with tuffs and flows and striking 27 degrees south of east and dipping vertically, from 600 feet north of lot post 43-44, range line VIII-IX, to a point 800 feet south of lot post 34-35, range line IX-X. This band, 1½ miles long, is comparatively straight, though slightly curving as indicated in places by the magnetic work. Dip needle work and outcrops indicated that this band of iron formation extends westward a farther distance of at least 1¼ miles. Eastward it was definitely traced for a farther distance of ½ mile. The total traced length of this band is thus 3¼ miles. Dip needle work along range line VII-VIII revealed local attraction on lot 58 and very probably indicates the presence of the same band of iron formation whose total determined length would then be 5½ miles. A little north of the west end of this traced zone, outcrops and dip needle work indicate the presence of at least three parallel bands of iron formation interbedded with tuffaceous sediments and flows. The width across the strike of the volcanics in which these bands occur is about half a mile.

The widest band of iron formation seen in Desmeloizes township measures 6 feet in width. The following section measured just north of the north boundary of lot 26, range X, Desmeloizes township, is typical of the iron formation as seen in this part of the map-area. The succession measured from north to south is:

	Feet
White-weathering, sheared, fine-grained, banded, green tuff	4
Green, fragmental rock containing lenticular bodies of sugary quartz	2
Fine-grained andesite flow	20
Fine-grained andesite flow. At the north edge of this flow, there is a 6-inch, lens-shaped fragment of magnetite with some quartz and epidote; apparently the fragment had been caught up in the bottom of the flow	15
Thinly-banded, iron formation	1
Fine-grained andesite flow	12
Iron formation in bands, paper thin to ½-inch wide, of chert, magnetite, and siliceous, fine-grained tuff; magnetite-rich bands form 50 per cent of the rock	6
Partly drift covered. Interbanded chert, banded iron formation, tuff, and, possibly, a thin flow. Iron formation possibly 5 feet wide	20
Fine-grained, basic andesite flow with chilled contacts	30
Banded, fine-grained, dark green tuffs	1
Basic andesitic flow banded near south contact	30
Cherty, dark tuff, intruded along bedding by a tongue-like dyke of feldspar porphyry having a maximum width of 4 feet	19

The bands in the iron formation range from paper thin to 2 inches in width, but most of them are of the smaller width. In thin section the rock is seen to be a mosaic of quartz having a grain of 0·1 millimetre, and magnetite grains. The magnetite is more abundant than quartz and its grains vary in size from smaller than, to about equal to, that of the quartz grains. Some bands are nearly pure magnetite and the most quartzose bands contain fine grains of magnetite. A little carbonate and occasional cubes of pyrite are present.

Age of the Sediments

Structural evidence indicates that although some of the main sedimentary bands are probably interbedded with the volcanics, the majority lie near or at the top of the volcanic assemblage along the axes of synclinal folds which have involved the Keewatin flows, the interbedded sediments, and the sediments at or near the top of the assemblage. No basal conglomerate or other evidence of a discordance between the volcanics and the sediments was found. Volcanics occur within nearly all the sedimentary bands and their presence and the other observed relations suggest that the sediments represent phases of Keewatin activity when erosion and sedimentation became dominant processes.

During the Keewatin period erosion, at times at least, was comparatively pronounced, as is indicated by the granite pebbles found in the 4-foot wide conglomerate band on the Abonde Mines, Limited, property in Desmeloizes township. This conglomerate band seems to lie low down in the Keewatin assemblage. The narrow conglomerate bands and other sedimentary layers interbedded with the volcanic flows at various horizons indicate that at least at intervals during Keewatin time, land areas existed with a relief sufficient to permit the play of forces of erosion and that bodies of water existed in which the sediments collected. Towards the end of the great period of vulcanism that characterized Keewatin time in this part of the Canadian shield, it seems as if the relief had increased, perhaps as a result of the long-continued processes of vulcanism, or because of some gradual crustal warping, or, perhaps, for both reasons, and that vulcanism slowly decreased in intensity while sedimentation increased and resulted in the accumulation of thick bodies of sediments, the eroded remnants of which are now represented by the band-like areas that have been mapped.

The more normal sediments and the iron formation are interbedded with flows, they are of the same age as the flows, and, therefore, definitely of Keewatin age.

GRANITIC ROCKS

The granitic masses of the Desmeloizes area are comparatively small and might be termed bosses or stocks. The age of the various granite and quartz diorite bodies is by no means certain. It may be that the masses are of two or more ages.

The already described occurrence on the property of Abonde Mines, Limited, in Desmeloizes township, of a 5-foot band of conglomerate holding pebbles of granite, indicates the existence or former existence of a granite body older than the conglomerate. The conglomerate is associated with tuffs, iron formation, and other conglomerate bands. All the sedimentary beds appear interbedded with flows, mainly andesitic, and appear to be an integral part of the Keewatin assemblage. The granite that afforded the pebbles to the narrow conglomerate bed, must have been older than the sediments and immediately associated volcanics. All the granitic bodies in the district seem younger than any part of the Keewatin, but the existence of the granite pebbles in the conglomerate may mean that all the granitic bodies are not of the same age. It may be that one or more of the bodies are of early Keewatin or even pre-Keewatin age. There is, of course, a possibility that the particular conglomerate bed referred to, and the immediately associated sediments and volcanics, are not Keewatin but, say, Timiskaming. The granite from which came the pebbles in the conglomerate would be pre-Timiskaming, but could be post-Keewatin. That is, so far as the conglomerate would indicate, all the granitic bodies might be of one general, post-Keewatin but pre-Timiskaming age. On the other hand there is reason for believing that most, if not all, the granitic bodies of the region are post-Timiskaming and there is no reason for suspecting that the conglomerate and associated sediments and volcanics are anything else but a part of the Keewatin. In any case the granite pebbles in the conglomerate indicate that there have been at least two periods of granitic invasion, though it may be, and not unlikely is, the case, that all the bosses of stocks in Desmeloizes map-area are of one general post-Keewatin age. It seems probable that all are post-Timiskaming but pre-Cobalt and, presumably, pre-Huronian.

A second set of phenomena which may indicate that all the granitic bodies are not of one age, is more fully discussed on a later page and need be only briefly referred to here. Within a few miles of the village of Dupuy, two dykes of granitic material cut a gabbro dyke which in turn cuts dykes of granitic material and one of the granite bosses. The two observed younger dykes of granitic rock may possibly be differentiates of the gabbro that produced the gabbro dykes, but if they are not they indicate that there may have been a granitic invasion of later date than that which produced some or all of the granitic bosses in Desmeloizes map-area.

The granitic rocks of Desmeloizes map-area, with the exception of those that will be called quartz diorite, are hereinafter called granites. They might equally as well be termed granodiorites, but in composition they do not conform to the generally accepted definitions of either granites or granodiorites, although they bear some resemblance to both these rocks. The feldspar present is albite or acid oligoclase with in some cases minor amounts of microcline. The rocks are not, therefore, true granites owing to their lack, or low content of, potassium-rich orthoclase or microcline. They are not true granodiorites as they do not contain appreciable amounts of the potash feldspars and contain no basic plagioclase feldspars. It seems better to think of them as soda granites in which the soda-rich feldspar is present to the almost total exclusion of the potash feldspars. As Harker[1] points out, soda granites are exceptional rocks. The granitic masses in northwestern Quebec are largely of this type and have been described in many instances as granodiorites.

Patten Creek Mass

In the area mapped north of the township of Desmeloizes and adjacent to the Ontario border, three granite masses were encountered and partly mapped. The westernmost, the Patten Creek mass, comprises 12 square miles of biotite-albite granite and is an eastern lobe of a body in the adjacent part of Ontario. The central and eastern part of the mass outcrops in prominent ridges separated by drift-filled valleys. The relief is from 50 to 80 feet. The northern and western parts are largely drift covered, but a few prominent ridges are present. The central part was not examined, but is known to be granite.

The granite is very massive. A flat sheeting and vertical jointing were noticed in some outcrops. The rock is coarse-grained with a tendency to be porphyritic, some of the feldspars being $\frac{1}{2}$ inch long and the biotite half this size. The rock has a speckled appearance due to the white and salmon pink feldspar, black biotite, and glassy quartz. Although considerable biotite is present the rock is not very dark coloured.

[1] Harker, F.: Petrology for Students, 1902, p. 30.

A thin section of a typical specimen taken fairly close to the edge of the granite body shows the mineral composition to be: 45 per cent feldspar; 40 per cent quartz; and 15 per cent biotite and accessory minerals. Rounded, idiomorphic oligoclase (An_{15}) individuals having an average diameter of 1·5 mm. form three-quarters of the feldspar content. In untwinned crystals a marked zoning is evident. The oligoclase shows a dusty type of alteration which in some cases is confined to zones within the crystal and may be zoisite as suggested by Phemister. There are also present in the feldspar, irregular grains of epidote and zoisite and flakes of sericite. The remaining quarter of the feldspar content is microcline showing its typical hatched twinning. The individuals are much larger than those of oligoclase and enclose them or are interstitial to them. Quartz fills irregular fractures in some of the crystals. A couple of imperfect myrmekitic intergrowths of quartz and plagioclase were seen. Many of the biotite flakes as seen in hand specimens appear roughly idiomorphic. In thin section this is not so evident, the biotite feathering out into the adjacent feldspars especially into the oligoclase. The biotite is strongly pleochroic from light to a dark brownish green. Large and small grains of epidote are associated with it and some appears to be primary and to have crystallized ahead of the biotite. The quartz occurs in aggregates of grains with crenulated margins. The aggregates may be as much as $\frac{1}{2}$ inch long, the individual grains being $\frac{1}{10}$ to $\frac{1}{20}$ of this size. Hair-like crystals, probably rutile, occur in the quartz and chert-like inclusions lie in lines. The quartz is allotriomorphic to the previously mentioned minerals. A few accessory grains of apatite and sphene are present.

Mapping of the volcanics adjacent to the granite body disclosed the presence of numerous granite dykes and a few of aplite and pegmatite. Most of the dykes are only a few feet wide and with only a few exceptions lie within half a mile of the contact.

What apparently is a contact phase of this granite mass occurs on its south contact in a poorly exposed outcrop $1\frac{3}{4}$ miles east of the Ontario-Quebec boundary. The rock is a hybrid rock and is a partial replacement of the adjacent volcanics by the granitic material of the mass. The rock is porphyritic, 5 per cent of its volume being phenocrysts 2 millimetres in diameter, of brick red albite; they lie in a dark grey, holocrystalline groundmass. The phenocrysts are partly altered to sericite and contain minute grains of what is probably hematite. The groundmass has a variable grain and consists of quartz and possibly feldspar, considerable chlorite probably penninite, sericite, and grains of epidote, ilmenite, leucoxene, and hematite. Similar rocks were found on the south contact of the Clermont-Chazel granite mass and in the vicinity of the Abana mine.

Three miles east of the Ontario border, a banding occurs in the granite close to the contact. The banding strikes parallel with the granite-greenstone contact and dips at 45 degrees towards the centre of the granite body. In a distance of 7 feet across the strike, three bands 1 to 3 inches wide, of biotite-rich granite, are interlayered with normal biotite granite, and a biotite-poor pegmatitic granite. In an outcrop on the contact a mile south-southwest, coarsely pegmatitic granite shows a gneissoid banding striking 20 degrees south of east and dipping vertically. This banding is due to crushing. As seen in thin section the feldspars, although showing crushing, tend to be euhedral. They form 75 per cent of the rock and are albite (An_6) and microcline in the proportion of 9 to 1. The feldspars are largely altered to sericite and contain numerous grains of zoisite and epidote. Quartz forms 10 per cent of the rock and occurs in lenses up to 1 inch in length and $\frac{3}{16}$ inch in width. The quartz shows crushing and strain. Biotite forms about 5 per cent of the rock, is highly chloritized, and contains a few small prisms of zircon. Zoisite and epidote also occur interstitially and form 10 per cent of the rock. A few diamond-shaped crystals of sphene and small grains of magnetite are present.

In a neighbouring outcrop a bluntly ending, steeply dipping granite dyke has forced banded andesite apart. The shape of the dyke and the structure in the andesite indicate that the intrusion came from a westerly direction.

Inclusions of volcanic rocks were seen $\frac{3}{4}$ mile east of the Ontario-Quebec boundary and also in an outcrop on the contact $3\frac{1}{4}$ miles east of the boundary. At this point an irregular dyke, 8 to 20 feet wide, of pegmatitic granite, cuts contact altered andesite. Near one of the dyke margins a corroded inclusion of the andesite, one foot long, was seen. The banding in this fragment corresponds in attitude to that in the adjacent country rock and this fact seems to indicate that the dyke may have largely formed by replacing rather than intruding the volcanics.

Along the well-exposed contact at the extreme eastern end of the granite mass, $4\frac{1}{2}$ miles north of the north boundary of Desmeloizes township, many inclusions were seen in the granite within a few tens of feet of the granite-greenstone contact. Most of the inclusions are lenticular, 10 to 40 feet long, and with widths measuring about one-quarter of their lengths. These fragments form 10 to 50 per cent of the area of the outcrops studied. They show no corrosion of their margins and if banded the banding closely parallels that of the country rock. The surrounding granite—normal, pegmatitic, or aplitic—sends dykes and stringers into the inclusions.

One-half and one mile north of these last-mentioned outcrops, numerous hornblende-rich inclusions were seen. These for the most part are only a few inches in diameter, but some are as much as 3 feet in diameter. These inclusions may be remnants of an intrusive older than, but possibly related to, the granite.

One and one-quarter miles northwest of these last-mentioned outcrops, at a place 3 miles east of the Ontario-Quebec boundary, is a large outcrop mainly composed of a somewhat similar, hornblende-rich rock, but containing opalescent quartz. The outcrop is just north of the inferred position of the volcanic-granite contact and the rock may also be intrusive in origin.

The volcanic rocks adjacent to the edges of the granite body are, in places, sheared, and this shearing wherever noted parallels the contact.

This relation is clearly shown for 5 miles along the curving southeastern contact. In this distance the shearing changes in strike through 110 degrees. The dip is usually vertical or steeply inclined.

Determinations of the attitudes of the volcanics adjacent to the granite body, from a point on the south contact, 2 miles east of the Ontario boundary, eastward and northward along an arc for 6 miles, show that the flows are vertical and strike parallel with the curving contact. Near the north contact, 2 miles east of the Ontario boundary, a vertical flow was noted that parallels the adjacent granite-volcanic contact. It is probable that the flows adjacent to the east boundary of the granite body also parallel the contact.

Along the southeastern part of the contact the tops of the flows face south or east. The granite mass has, therefore, apparently intruded an anticlinal structure in the volcanics. Owing to the comparatively smoothly curving course followed by the granite-volcanic contact it is inferred that the contact is essentially vertical for at least some distance below the present surface.

Pajegasque Mass and Small Mass South of It

Pajegasque mass lies in the area north of Desmeloizes township. Pajegasque lake lies largely within this mass and it is after this lake that the body is named. The mass and the adjacent volcanics are well exposed, outcrops being continuous for long distances. The contact was seen at many points and the general line of the contact is closely delimited. The body of granite south of the Pajegasque mass is poorly exposed and its boundary could not be precisely located.

From a mile north of Pajegasque lake the northern mass is a light coloured granite low in ferromagnesian minerals. The southern part of this mass and the smaller separate mass still farther south, are of a darker rock which in some respects resembles the Patten Creek mass previously described.

The northern light coloured rock is coarse grained, the individual minerals in some cases being as much as 8 millimetres in diameter, but usually they are aggregates of crushed grains $\frac{1}{5}$ to $\frac{1}{15}$ of the above size. Ovoids of biotite averaging 1 inch in diameter were seen in one place a little east of the contact. These ovoids were from half a foot to 3 feet apart and may be a contact phenomenon. The mineral content of the light-coloured rock is approximately 50 per cent feldspar, 45 per cent quartz, and 5 per cent mica. In thin section the feldspar is seen to be 80 per cent oligoclase (An_{12}) and 20 per cent microcline. The oligoclase is usually idiomorphic, is zoned, and is much altered largely in the central parts of the crystals. The alteration products are small grains and flakes of zoisite, epidote, and sericite. The microcline occurs in large crystals and is interstitial to the plagioclase. The microcline contains veinlets and tiny lenses of quartz. Myrmekitic intergrowths were noticed on the borders of the oligoclase. The micas are biotite and muscovite. The biotite is a brown pleochroic variety and occurs chiefly in long, shred-like crystals. The muscovite is closely associated with the biotite and is similarly developed. Some of the biotite is partly altered to chlorite. Many individuals of the two micas have curved cleavage planes. The quartz is allotriomorphic and boundaries between grains are crenulated. Crushed grains, many of which involve adjacent minerals, occur. Inclusions in the quartz are rare. Besides the zoisite developed in the feldspars, grains of the mineral appear to be interstitial. A colourless garnet was noted. Except for the presence of muscovite and the general low ferromagnesian mineral content, this granite resembles the granite of the Patten Creek mass.

The feldspars of the darker rock that forms the southern mass are white or soapy looking. In an outcrop cut by a large diabase dyke the feldspars are green and, in places, salmon pink. The quartz is notably opalescent; the ferromagnesian constituent is biotite or its alteration products.

Gneissoid banding was not noticed in either mass and inclusions of the country rock are rare except towards the centre of the southern mass where large greenstone masses, probably roof pendants, were seen. A fine-grained, dark rock, probably dioritic in composition, occurs in places along the contact and is probably a hybrid contact rock. The adjacent volcanics are massive, fine-grained in many places, and on fracture surfaces have a glistening appearance. Granitic and aplite dykes, mostly small, occur close to the edges of the bodies.

Clermont-Chazel Mass

A poorly exposed body of albite-biotite granite extends into the north parts of the townships of Clermont and Chazel. Its length from west to east is 13 miles. Its width towards the west end is probably less than 2 miles and is a lobe-like extension of a large body extending far north of the map-area. The southern margin is heavily drift covered.

Outcrops within the mass are few, but some are large. The rock is massive and for the most part light coloured because of the white, creamy, or slightly greenish feldspar. This feldspar and glassy or opalescent quartz and biotite are the main constituents. In a few outcrops the feldspar has a reddish cast which gives a pinkish tone to the rock. The grain is coarse, averaging 1·5 millimetres.

The study of five thin sections shows the rock to be composed of from 55 to 70 per cent feldspars, 20 to 40 per cent quartz, and 5 to 15 per cent ferromagnesian minerals. The feldspar ranges from albite (An_6) to albite-oligoclase (An_{10}) and is anhedral. No potash feldspars were seen. Some of the feldspar is not twinned and some of these untwinned crystals show zoning. Alteration of the feldspar varies from slight to very great. The greatly altered feldspars are mats of white mica; zoisite was noticed in two sections. The reddish feldspars of the pinkish variety of the rock are filled with extremely fine particles of hematite or limonite probably produced by surface weathering. Some crystals show a minute flecked pattern probably related to twinning. The quartz, glassy or opalescent in hand specimens, is seen in thin section to be allotriomorphic and to contain minute inclusions and cavities. Strain and crushing are evident in one thin section. Fine-grained quartz appears in veinlets cutting the feldspar. Carbonate is closely associated with the quartz veinlets. Aggregates of biotite or what are presumably its alteration products, have in most cases a shredded, irregular outline. Most of the biotite is much altered to chlorite, and penninite. A lattice structure of rutile needles, crossing one another at 60 degrees, occurs in some of this secondary penninite. A little zoisite is associated with the alteration products of the biotite. A few accessory minerals are present and are: apatite; zircon, some grains of which are zoned; rutile in fine needles; and epidote in allotriomorphic twinned crystals and in irregular grains.

The volcanics near the borders of the mass are for the most part sheared, the shearing planes are vertical and parallel the contact. At the southeastern corner of the mass what appeared to be a hybrid rock has an augen structure, the augens being feldspar and quartz and lying in a groundmass of chloritic-looking material.

The rock of this mass differs from the rocks of the three previously described masses in its lack of potash feldspar and in the more acid nature of the plagioclase, but in other respects the rocks are much alike and possibly all four masses are parts of the one batholithic body.

Desmeloizes-La Reine Masses

In the western parts of the townships of Desmeloizes and La Reine are three areas of outcrops of granitic rocks separated from one another and the adjacent volcanics and sediments by stretches of drift-covered country. The three areas of granitic rock may be parts of one mass extending a considerable distance westward into Ontario. The outcrops within the three areas are few and small. These exposures show the rock to be massive. In the eastern part of the two townships are three small, detached areas of outcrops of granitic rocks which on petrographic grounds seem to be related to the rocks of the three areas just mentioned.

The central part of the northernmost and largest area in western Desmeloizes township is occupied by a light-coloured oligoclase-microcline-biotite granite. Phases have large phenocrysts of feldspar up to $1\frac{1}{2}$ centimetres in length in a finer-grained groundmass of aggregates whose component grains have an average diameter of 1 millimetre. The feldspars are white to pale pink and compose 75 per cent of the rock. Biotite forms 10 per cent and quartz 15 per cent of the total mass. A thin section shows the feldspar to be 80 per cent oligoclase (An_{13}). Microcline and myrmekite, abundant in spots, form 20 per cent. The oligoclase is fairly fresh, is idiomorphic or hypidiomorphic, and some crystals show faint zoning. The alteration products are small quantities of white mica and a few grains of epidote. The microcline is interstitial and fresh. Some of the patches of myrmekite are as much as 1 millimetre in diameter, are typically developed between the oligoclase and microcline, and although usually occurring as embayments in the microcline the myrmekite also seems, in places, to have developed at the expense of the oligoclase. The micas are apparently of three types: a colourless mica, uniaxial and negative which may be phlogopite; a colourless biaxial mica presumably muscovite; and a pleochroic, dark brownish green to light green biotite. The colourless micas are euhedral and crystallized ahead of the biotite. Quartz is allotriomorphic and shows no strain; inclusions are not numerous. The accessory minerals are sphene, apatite, zoisite, and epidote. Some of the epidote is zoned and may be primary.

The above-described oligoclase-microcline-biotite granite occupies, as already stated, the central parts of the granite area, the periphery, a zone approximately 1 mile wide, is of a rock of somewhat different composition. It varies from a biotite-hornblende granite to a syenite. It is darker in colour than the previously described rock because of its higher ferromagnesian mineral content. Two thin sections of the granite phase were studied. In them feldspar forms 65 per cent to 70 per cent, quartz 10 to 25 per cent, and ferromagnesian minerals 10 to 20 per cent of the rock. In the syenite phase the quartz content is lower and that of the dark minerals is higher. The feldspar is albite-oligoclase (An_{10}). Microcline is absent, but myrmekitic intergrowths were seen. The ferromagnesian minerals are biotite and hornblende with usually an appreciable amount of epidote. The biotite usually predominates over the hornblende and occurs in equidimensional flakes with ragged edge. Some of the mica has altered to penninite. The hornblende is deep green with pleochroism from deep green to straw yellow. The biotite and hornblende probably crystallized contemporaneously. Biotite occurs in the centres of a few hornblende crystals. Epidote is present in irregular grains and euhedral crystals; some of the crystals are surrounded by biotite and may have crystallized earlier than this mineral. Quartz is interstitial and some of it shows strain. Accessory minerals are euhedral sphene, apatite, and pyrite.

The northern of the two small areas in western La Reine township is occupied by an oligoclase-hornblende syenite or diorite containing a little quartz and closely resembling the peripheral phase of the larger body just described. The southern of the two areas is an oligoclase-biotite-hornblende granite also like the granite of the peripheral phase of the large body described above.

The contact of the larger body, in Desmeloizes township, is intermittently exposed for a length of about 1,000 feet. The bordering rocks along this contact are highly altered, the commonest kinds being biotite- and hornblende-rich schists whose original nature is not evident. Highly altered rocks that appear definitely to have been andesite and rhyolite flows are interbedded with slaty rocks that are probably altered tuffs. A few dark bands, much contorted, contain garnets. The assemblage is cut by numerous dykes of granitic rocks which vary from varieties low in biotite to others high in this mineral, have a gneissoid structure, and somewhat resemble many of the schists. The dykes are usually narrow, are very sinuous, and give the impression of having been intruded when the country rock was in a plastic state. The country rock in places is of the nature of a banded gneiss probably due to replacement by granitic material, along bedding or structural planes. Minor faults cut many of the dykes. Many of the outcrops of the volcanics and associated rocks are rusty at the surface and trenches on the property of the La Reine Mines, Limited, have disclosed small amounts of pyrite, pyrrhotite, sphalerite, galena, and chalcopyrite, disseminated or associated with quartz and usually in graphite-rich slates.

South La Reine Mass

Along the south edge of the map-area, in range III, La Reine township, is an area 1 mile wide and 5 miles long of albite granite which is the northern extension of a mass 6 miles long east and west and 4½ miles wide called by Buffam the La Reine batholith. This mass is poorly exposed in small, scattered outcrops.

The rock has a faint gneissoid structure, is medium to coarse grained, and light grey to pink. It is composed of from 55 to 70 per cent feldspar, 15 to 30 per cent quartz, and 3 to 10 per cent ferromagnesian minerals. Practically all the feldspar is believed to be albite. Some of the feldspar is much altered, especially the central parts of individuals, to white mica with some epidote and possibly may be more basic than albite. The plagioclase occurs in euhedral or hypidiomorphic grains having a diameter of 1 mm. A little interstitial, fresh microcline and a few myrmekitic intergrowths were seen. The feldspars show little or no crushing. Much of the quartz is in lenticular masses 1 centimetre long and lying parallel with the foliation of the rock. The quartz for the most part is coarsely granular and shows wavy extinction. Some quartz grains with sutured boundaries are interstitial and may be secondary. The biotite is strongly pleochroic from dark brown to straw yellow and much of it is altered to chlorite. Most of the flakes are irregular or feathery, show bending, and in some cases are interstitial to the feldspar. The flakes vary in size from ½ inch to minute specks. Some euhedral flakes of white mica are associated with the biotite; this mica is uniaxial and negative and is probably a colourless phlogopite. Epidote in places forms half the ferromagnesian mineral content, much of it is euhedral and penetrates the biotite flakes. Zircon, sphene, and apatite are accessory.

The northern contact of the mass closely conforms to the direction of shearing in the adjacent volcanics.

La Sarre Mass

In the southwest part of the map-area is a body of granite 10 miles long east and west and 3½ miles wide at the western end. It is the northern part of a mass extending 3 miles south of the south boundary of the map-area. Outcrops are numerous and some are large.

The mass, within the map-area, is mainly a dark hornblende syenite or quartz syenite varying in composition and texture. A light coloured, granitic phase occurs in a large outcrop, near the northwest extremity, in the north part of range V, lots 21-25. In this outcrop is a quarry from which is being obtained the rock for the La Sarre church.

The syenitic rocks are cut by dark dykes of granodiorite and rock similar to the granodiorite is cut by granite dykes. The granodiorite of the dykes is porphyritic in places, the phenocrysts being feldspar. A gabbroidal phase was seen in the southeast part of the area. The relationships of the various rock types are not at all clear.

The granite phase seen, as already stated, in the large outcrop in the northwest part of the mass, is a whitish pink, coarse-grained, porphyritic albite-hornblende granite composed of 80 per cent feldspar, 15 per cent quartz, and 5 per cent ferromagnesian minerals. The phenocrysts are large albite (An_6) individuals up to 2 centimetres in length and they lie in a groundmass of 1 to 2 millimetres grain, composed of hypidiomorphic albite, euhedral hornblende, some microcline, and allotriomorphic quartz. The albite of the large phenocrysts but not of the groundmass is zoned. Some of the crystals are crushed. The microcline occurs, in part, as irregular patches in the centre of albite phenocrysts. Some microcline crystals partly occupy bays in albite and contain small crystals of albite and irregular remnants of albite grains which have the same orientation as the adjacent larger albite individuals. The relationships strongly suggest replacement of the albite by microcline. Other grains of microcline are interstitial to the albite. No myrmekite was seen. The albite is not altered. The microcline is filled with dust-like particles giving it a cloudy appearance. The chief ferromagnesian mineral is a euhedral hornblende with low birefringence, which is pleochroic from blue green to a light dirty green to almost colourless. It is, apparently, a soda hornblende. It is not altered. It holds inclusions of plagioclase. The accessory minerals are titanite and epidote.

The dark syenitic phase varies as regards the quantities of ferromagnesian minerals present and, in grain, varies from 8 mm. to 2 mm., the latter dimension being about the average. The rock is in part faintly gneissoid, particularly so in the western part of the mass in lots 30-33, ranges II-III, La Sarre township. The gneissoid structure there strikes north 50 degrees west parallel with the structural trend of the Keewatin. Inclusions of medium to fine-grained, basic rocks, which are probably fragments of the intruded volcanics, occur locally in the marginal part of the mass. The inclusions are dioritic looking, and may be related to the dioritic masses in the area.

The feldspar of the syenitic phases is predominately hypidiomorphic albite or oligoclase, altered in spots within individuals to a mat of flakes of white mica and small grains of epidote. Microcline in varying, much smaller, quantities has interstitial relationships, but shreds of plagioclase are present within some individuals. Myremkitic intergrowths are common. The relative amounts of the two feldspars are variable. Interstitial quartz, much of which shows granulation, is present and forms 10 per cent or less of the rock mass. The chief ferromagnesian mineral is a fresh, dark green, pleochroic hornblende in which bleb-like inclusions of quartz are common. Associated with some of the hornblende are flakes of a strongly pleochroic, brown to straw yellow, biotite, and grains, usually irregular, of slightly pleochroic epidote. The accessories are apatite, titanite, and magnetite. A little secondary calcite occurs in some plagioclase individuals.

The schistosity in the volcanics bounding the granitic mass closely parallels the inferred course of the contact. The granitic body apparently lies within a north-pitching, anticlinal area in the volcanics. Its north edge is close to and parallels the synclinal axis of the Desmeloizes sedimentary band.

Makamik Mass

A small area of granodiorite and related rocks occurs along the southwestern shore of lake Makamik. It is a northwestern extension of the Robertson Lake batholith which extends 15 miles southeast of the map-area and widens to a breadth of 6 miles. Within the map-area outcrops are few except on the lake shore.

The northwestern end of the part of the mass lying within the map-area is a medium-grained, light pink, oligoclase granite, low in ferromagnesian minerals. Hypidiomorphic oligoclase (An_{12}) forms 65 per cent of the rock and is largely altered to a mat of white mica holding a small amount of chlorite and some grains of epidote. No microcline was seen. Quartz forms 25 per cent of the rock; many of the grains have intricate sutured boundaries; gas inclusions are common. The remaining 10 per cent of the rock is largely epidote in large, irregular grains, with which are associated minor amounts of white mica, chlorite secondary after biotite, and a little green pleochroic hornblende. Titanite occurs in large grains. A little secondary carbonate is present.

In range III, lots 26-28, the granodiorite holds inclusions of hornblende diorite with a ferromagnesian mineral content of 75 per cent, whereas the granodiorite in this locality has 50 per cent. A pyroxenite in this same outcrop seems to be related to the granodiorite and diorite. Elsewhere blocks and shreds of blocks of hornblendic rock were seen.

A small outcrop of massive granite was seen in lot 9 just south of range line IX-X, Royal-Roussillon township. The rock closely resembles the acid phase of the Makamik mass as described above except that a little microcline is present.

Quartz Diorite

Quartz diorite, in ranges VIII to X between lots 16 and 35, La Sarre township, forms a body 4 miles long and 1½ miles wide, trending parallel with the general strike of the neighbouring sediments and volcanics. Within this mass as mapped are considerable areas of highly altered basic volcanics which are difficult to differentiate from the diorite. A second body of diorite is close to the north short of lake Makamik in lot 20, range VIII, to lot 28, range VII, Royal-Roussillon township. It is 1¾ miles long, trends northwesterly like the first-mentioned mass, and also holds shreds of greenstone. Dykes and small bodies of quartz diorite outcrop between these two larger bodies, notably in lot 45, range IX, and lot 48, range IX, La Sarre township. Hornblendite phases occur in lots 7 to 10, range VIII, Royal-Roussillon township.

The quartz diorite varies in colour with the varying hornblende content, but is usually blackish with a greenish cast. A lighter coloured phase, studied under the microscope, has a grain of about 2 millimetres and is composed of about 65 per cent plagioclase, 25 per cent hornblende, and 10 per cent quartz. A finer, darker phase has a grain of 0·3 millimetre and is composed of about 25 per cent plagioclase, 60 per cent hornblende, and 15 per cent quartz. The feldspar is much altered, but parts of some crystals are still of fresh feldspar and fresh, untwinned grains are common in the finer-grained parts of the rock. The feldspar is oligoclase-andesine (An_{30}). The hornblende is undecomposed, blue-green to pale yellow-green, and occurs in irregular, ragged crystals many of which contain blebs of quartz and some of which show pleochroic haloes around minute inclusions. The hornblende much resembles that found in the granites of the map-area. Accessory amounts of brown biotite, epidote, sphene, calcite, and, in some examples, pyrite, are present.

No direct evidence was obtained of the relative ages of the quartz diorite and the granites, but, on petrographic ground, the quartz diorite is believed to be closely related to at least some of the granite masses. Basic phases of the granite masses, such as the Desmeloizes masses and the La Sarre mass, have a slight petrographic resemblance to the diorite.

Later (?) Granite

A mile and one-half north of Dupuy village, on the south part of lot 36 just east of the north-south road, a large outcrop of a north-south gabbro dyke is cut by a granitic dyke 1 to 2½ inches wide and exposed for a length of 35 feet. In one of the wide parts of the dykelet, angular fragments of the gabbro lie in the granitic material. Two miles south of Dupuy village, on the north part of lot 48, range XI, a finer-grained dyke of granitic material cuts the same north-south gabbro dyke and also the adjacent gabbroidal volcanics. This dyke is 4 inches wide. Dykelets of the same granitic rock cut the gabbro dyke at other points in this vicinity.

A thin section of the narrow granitic dyke cutting the gabbro dyke south of Dupuy shows the rock to be an aplite having a grain of 0·5 to 1·0 millimetre and is composed of 30 per cent plagioclase, 60 per cent quartz, and 10 per cent ferromagnesian minerals. The feldspar is albite (An_9), occurs in hypidiomorphic, stumpy laths and is considerably altered to dust-like particles of white mica, epidote, and zoisite. The quartz has been one of the last minerals to crystallize and contains inclusions of albite laths, ferromagnesian minerals, and iron ore. The ferromagnesian minerals are zoisite and chlorite. The zoisite is colourless and occurs in irregular-shaped, small grains many of which have a radiating structure indicated by a black cross when the material is viewed with crossed nicols. The chlorite is probably secondary after hornblende. Accessory grains of sphene and of what is probably titaniferous magnetite are present.

The gabbro dyke cuts granitic dykes believed to be offshoots of a granite mass in northeastern La Reine township, it also cuts the mass of granite in south La Reine. The gabbro dyke is, therefore, younger than these two granite masses. The two small dykes that cut the gabbro dyke are, therefore, also younger than the two granite masses mentioned. They were intruded after the solidification of the gabbro dyke and, since the gabbro dyke is one of the youngest rocks of the district and may be of post-Cobalt age, they are, so far as known, the youngest igneous rocks, and may indicate a comparatively, very late granite invasion. However, since there does not seem to be any granitic body in their vicinity to which they might be attributed it is possible, perhaps probable, that the granitic dykelets are later differentiates of the gabbro magma which gave rise to the north-south gabbro dyke.

PERIDOTITE

A 6-foot dyke of altered peridotite cuts volcanics on lot 50, range IX, La Sarre township. The dyke strikes north. No other peridotite body was found within the map-area. The peridotite displays the typical white weathering usual with these rocks and the weathered surface has the characteristic soapy feel. Close inspection of the weathered surface shows the rock to be composed of angular grains, from 1 to 3 millimetres in diameter, separated from one another by paper-thin, dark partings. In thin section nearly every grain is seen to be fibrous, colourless serpentine having a blue-grey interference colour. The centres of some of the grains are yellow-brown fibres of what is possibly chlorite. Magnetite occurs in iregular grains up to 0·3 millimetre in diameter. The partings between the grains have a fairly uniform width of 0·15 millimetre and are composed of carbonate probably ferruginous. There seems to be little doubt that the rock is a highly altered peridotite. In the district to the south, similar dark rocks cut a granodiorite mass. The dyke found in La Sarre township cuts volcanics, but may also be younger than some or all of the granitic masses in the map-area.

DIABASE DYKES

There are numerous diabase dykes within Desmeloizes area and they are divisible into two groups; those striking north-south and those striking northeast-southwest. It is considered that the two groups are of different ages. Each is divisible into two divisions, differing petrographically. A considerable number of dykes were found, but it is certain that others remain undiscovered.

North-South Group

Abana Dyke. A north-south diabase dyke cuts the ore zone in the Abana mine and hence has been named the Abana dyke. Two sections of this dyke were traced and mapped. A northern section was traced for nearly 3 miles from the north boundary of Desmeloizes township at lot post 45-46, south to the centre of range VIII on lot line 43-44. Southward, beyond this, the country for a distance of 8 miles is largely drift covered and outcrops of the dyke were not found. Commencing in the south part of lot 46, range X, La Reine township, the dyke was traced in numerous outcrops for 8 miles to lot line 48-49, range II, La Reine township. Twenty miles south of the south boundary of the map-area, a north-south dyke has been traced from a point on the south half of the Montbray-Duprat township boundary southward into the northwest corner of Boischatel township where it swings southeasterly and continues for 5 miles to near the north edge of an area of Cobalt strata. This southern dyke is similar petrographically to the Abana dyke and may be a continuation of it. If so, the dyke has a length of at least 55 miles.

The southernmost outcrop of the north section of the Abana dyke is on lot line 43-44, range VIII, Desmeloizes township, and there the dyke is about 150 feet wide. Drilling on the Abonde, Abana, and Abaco properties has indicated its presence, under heavy drift, over a length of 3 miles, north to the north boundary of Desmeloizes township. On the Abonde property drilling near the west boundary of the north half of lot 44, range IX, shows that the dyke there strikes north and that it is covered by 80 or more feet of drift. To the north, on the Abana, the underground workings intersect the dyke on the 300-foot level where it has a width of 190 feet and a strike a little east of north. On the Abaco property, the dyke was penetrated by drilling on the north boundary of Desmeloizes township. North of this point, the country is largely drift covered and the dyke was not recognized.

At lot post 38-39, range line VIII-IX, Desmeloizes township, about one mile west of the Abana dyke, a diabase dyke 12 to 15 feet wide cuts greenstone and strikes north 30 degrees east. The dyke resembles the Abana dyke and is probably of the same age. The Abana dyke varies somewhat in appearance, but is generally dark with a greenish cast, coarse grained in its central parts, and fine grained at the margins. It is distinguished from the other gabbro or diabase dykes found in the area by the presence of a porphyritic texture. The phenocrysts are irregular-shaped, greenish feldspar aggregates which form from 5 to 15 per cent of the rock and have a diameter of as much as 1 inch. These aggregates occur not only in the central part of the dyke, but also in its chilled margins.

Under the microscope the phenocrysts are seen to be composed of more than one individual of plagioclase feldspar, generally idiomorphic, but with their outlines in places modified, since, apparently, the final stages of growth were contemporaneous with the growth of the minerals of the groundmass, for the small plagioclase crystals of the groundmass are idiomorphic in some places where parts of them are involved in the margin of one of the phenocrysts. The augite is interstitial, holds small, euhedral plagioclase crystals of the groundmass and in places shows a sinuous boundary against the plagioclase phenocrysts as if the stages of crystallization had overlapped.

The plagioclase phenocrysts are considerably altered. The unaltered parts are labradorite (An_{55}), as also are the feldspars of the groundmass. The alteration has, for the most part, resulted in the production of brown patches of dust-like material largely of zoisite with some epidote and irregular flakes of what is probably white mica. The alteration resembles that described by T. C. Phemister as occurring in the plagioclase of the Cobalt diabase sill.[1] In a section of a specimen taken from the dyke, 12 feet from its western margin, on the 300-foot level of the Abana, veinlets of chlorite traverse some of the phenocrysts and separate perfectly fresh

[1]Phemister, T. C.: "A Comparison of the Keweenawan Sill-Rocks of Sudbury and Cobalt, Ontario"; Roy. Soc. Canada, vol. XXII, pt. 2, sec. 4, p. 147.

parts of the feldspar from altered parts. The chlorite veinlets seem to have limited the areas of alteration and, therefore, appear to have been introduced before alteration took place.

The groundmass has a diabasic texture. Laths of labradorite (An_{55}) form, on an average, 50 per cent of the groundmass and have perfect euhedral forms, from 0·2 to 0·4 millimetre wide and 1 to 2·5 millimetres long. Most of them show a little alteration in patches and secondary material resembling that seen in the phenocrysts. White mica and chlorite are present in other parts of the crystals. Augite, probably diopside, is interstitial to the feldspar, is pale of colour, non-pleochroic, and forms 40 to 45 per cent of the groundmass. The augite is not much altered, but in parts shows a salite structure which gives it the appearance of being altered. In other parts it is altered to strongly pleochroic green hornblende. Aggregates of strongly pleochroic brown biotite, chlorite, and magnetite are present and may be largely secondary after augite. The augite is probably titaniferous, as leucoxene grains appear around some of its margins. Some of the leucoxene grains have diameters of 1 millimetre, are embayed and bear inclusions, and probably formed during the earliest stages of crystallization. The leucoxene forms from 1 to 2 per cent of the rock volume. Quartz and micropegmatite form from 3 to 10 per cent of the rock volume and were the last materials to crystallize. The feldspar of the micropegmatite was, in one case, determined to be andesine (An_{36}); most of it is much altered and in one case it was completely replaced by chlorite. The accessory minerals are small needles of apatite more abundant in the micropegmatite than elsewhere, a little pyrite usually in irregular grains, and magnetite.

A section of a specimen from the chilled margin of the dyke where it is in contact with rhyolite on the 300-foot level of the Abana shows labradorite (An_{55}) phenocrysts similar in composition and size to the feldspar of the groundmass of the coarser central part of the dyke. The feldspar phenocrysts are not altered. There are also rounded phenocrysts of the same sizes as the feldspar phenocrysts, of colourless, twinned diopside like that in the coarser parts of the dyke. The groundmass is extremely fine and is dark in colour, due largely to the presence of 30 per cent of iron ore. The rest of the ground is a matt of, probably, plagioclase and brown biotite. The plagioclase phenocrysts are oriented parallel with the contact. Several broken phenocrysts are present. Apparently the feldspars had crystallized before intrusion. Rounded fragments of the rhyolite of the wall-rock occur in the chilled contact. Most of them are surrounded by a rim of white mica.

The line of contact between dyke and the rhyolite country rock is minutely crenulated. Intervening between the dyke and the rhyolite is a reaction zone, 2 mm. wide, which for a tenth of its width against the dyke is composed of fine-grained white mica, the composition of the rest of the zone is difficult to determine but apparently holds a high percentage of white mica and zoisite. A bleached zone 2 millimetres wide, and brown in colour, forms the outer margin of the dyke and within it the augite has altered to ziosite. The chilled contact against rhyolite is 0·5 cm. wide, but against the ore on the 300-foot level on the Abana mine, it is 5 cm. wide.

The dyke close to the ore is in many parts impregnated with fine-grained pyrite some of which occurs in stringers less than 0·5 mm. wide. The sulphide, evidently, was acquired at the time of intrusion, from the pyrite-rich body, for the increased width of the chilled margin presumably resulted from the pyrite being a better conductor of heat than the rhyolite and thus being evidence that the dyke was intruded after the sulphide orebody had formed.

The Abana dyke in most places displays an irregular jointing which has produced blocks 1 to 4 feet thick. Most outcrops project above the adjacent greenstone or granite, but on the Abana property the dyke has been found by drilling to follow a drift-filled depression probably averaging 80 feet in depth. In the north half of lot 44, range IX, Desmeloizes township, where drilling indicates that the dyke is covered by 80 feet of drift, greenstone outcrops in a prominent ridge 150 feet east of the dyke. The differential erosion of the dyke in this vicinity may have been largely glacial, the rock being easy to pluck owing to the jointing and, possibly, erosion was accelerated as the result of the existence of a strong, vertical fault cutting the diabase dyke and seen on the 300-foot level of the Abana mine 80 feet east of the west edge of the dyke. The fault zone is 8 feet wide and filled with brecciated diabase and gouge-like material.

Other North-South Dykes. Besides the Abana dyke three, or, possibly, four other north-south striking quartz diabase dykes were seen. Three and a half miles east of the Ontario-Quebec boundary and extending between points respectively ½ and 2½ miles north of the north boundary of Desmeloizes township, is a well-exposed dyke 60 to 120 feet wide. In La Sarre township from range II to range VIII and less than 2 miles east of the west boundary of the township, are six outcrops of diabase which are believed to be parts of one or, possibly, of two dykes striking north-south. In Clermont township in lot 5, range line I-II, a dyke outcrops that probably also strikes north-south.

These three or it may be four dykes show an ill-defined, blocky jointing. They have narrow, chilled margins 0·5 centimetre or so wide and for a few feet away from the margins gradually increase in size of grain until the normal coarse-grained central part is reached. Fine-grained dykelets, 2 inches or so wide, branch from these dykes.

These dykes resemble the Abana dyke, but lack the large phenocrysts of feldspar except in one outcrop where one phenocryst was seen.

Northeast-Southwest Group

Quartz Diabase Dykes. Quartz diabase dykes striking northeast-southwest were recognized in two parts of the map-area. Outcrops believed to belong to seven such dykes were found in the northwest part of the area and to five in the eastern part.

One of these dykes in the northwest part of the area north of Desmeloizes township was traced by intermittent outcrops over two sections situated, respectively, south and north of the Patten Creek granite mass. The gap between the two sections, within the Patten Creek granite mass, was not traversed. In the southwestern section, this dyke widens from 60 feet in its southernmost exposure to 170 feet in its northernmost outcrops; in the northeastern section the width is about 180 feet.

Outcrops of what may be one diabase dyke about 20 feet wide were found at long distances apart over a distance of 3½ miles, commencing at a point 3½ miles east of the Ontario boundary and 2¾ miles north of the north boundary of Desmeloizes township and extending to a point ¼ mile north of the west end of Pajegasque lake.

A dyke approximately 180 to 300 feet wide crosses the north boundary of Desmeloizes township at lot 25. It was traced by intermittent outcrops for 4¾ miles northeasterly and 2 miles southwesterly. It possibly extends at least 3 miles farther southwesterly if a poorly exposed outcrop in range VIII, Desmeloizes township, is of the same dyke. This dyke is cut by a north-south diabase dyke in lot 26 on the north boundary of Desmeloizes township. It appears to be displaced by a fault in lot 16, range IX, Desmeloizes township.

An isolated outcrop of quartz diabase supposed to belong to the dyke group under discussion occurs in a drift-covered area on the north part of lot 36, range V, Desmeloizes township.

What is believed to be a single large dyke, 200 feet to 600 feet wide and at least 21 miles long, runs in a northeasterly direction across the northwest corner of La Reine township, southeast corner of Desmeloizes township, and the north part of Clermont township. Outcrops of this supposedly single dyke are not numerous. Faulting is suggested by the relative positions of different sections.

The edges of the dykes are chilled. Within a few millimetres from the edges, the rocks are fine-grained, grading rapidly into a coarse middle phase. The large dykes are quite coarse in the centre, the grain reaching 6 millimetres. The margins of all dykes and the whole width of dykes 50 feet or less wide, usually show a diabasic texture which is not as evident in coarser phases. The rock is fresh looking, dark, with a greenish cast. The composition as indicated by four thin sections is approximately 45 to 65 per cent plagioclase, 30 to 50 per cent ferromagnesian minerals, 1 to 15 per cent quartz and micrographic intergrowths, 1 to 3 per cent accessory minerals, magnetite, biotite, apatite, and pyrite. The plagioclase is labradorite (An_{60}) and in the finer-grained phases occurs in idiomorphic laths. In the coarser phases the feldspar is also idiomorphic, but does not tend to occur with as pronounced ophitic relationships to the augite as in the finer-grained varieties. The coarser phases are rather gabbroidal than diabasic in texture. About one-half of the feldspars are altered in spots to aggregates of white mica flakes. A little epidote and zoisite and, more rarely, a little chlorite, occur in the feldspar. The original ferromagnesian mineral was, apparently, allotriomorphic, now much altered, augite much of which has a striated appearance, and a non-pleochroic, light yellow-brown colour. Strongly pleochroic, pale yellow-green to blue-green hornblende, probably largely secondary, also occurs. Areas of serpentine are present. Quartz occurs in allotriomorphic grains and as part of micrographic intergrowths of quartz and a mineral now replaced by chlorite. The grain of the micrographic intergrowths is usually quite fine. Magnetite, probably largely secondary after augite, occurs in aggregates of grains with some associated chlorite and biotite. A few euhedral grains of magnetite are probably primary. A little biotite is associated with the hornblende and may be primary. Grains of titanite are present and also a few euhedral, slender prisms of apatite. A few grains of pyrite occur in some sections.

Olivine Diabase Dyke. A few outcrops in southern Desmeloizes township indicate the presence of an olivine diabase dyke extending from lot 5, range II, to lot 54, range line V-VI. What may be a continuation of the same dyke occurs at the south end of lot 10, range VI, Clermont township. Where best exposed, the dyke strikes north 70 degrees east.

The olivine diabase has a grain of about 5 millimetres. The diabasic texture is prominent, the lath-shaped feldspar crystals plainly penetrating the dark ferromagnesian minerals. The rock is composed of about 55 per cent feldspar, 20 per cent olivine, 20 per cent augite, 5 per cent magnetite, 2 per cent apatite, and minor amounts of alteration products. The feldspar is andesine-labradorite (An_{50}). It occurs in lath-shaped, idiomorphic individuals penetrating the pyroxene. About 30 per cent of the feldspar individuals are altered in patches to minute flakes of white mica. The olivine occurs in large grains and is allotriomorphic, having crystallized later than the feldspar but earlier than the augite. The mineral is colourless or slightly greenish and is slightly altered to serpentine usually associated with a little fine-grained iron ore, probably magnetite, and a little red biotite. The alteration follows fractures or lies at the borders of the crystals. The augite is perfectly fresh, light purplish, slightly pleochroic, and apparently, is titaniferous. It occurs in large grains and crystallized later than all the constituents except biotite. The magnetite occurs in grains up to 2 millimetres in diameter, many are idiomorphic; it apparently crystallized at about the same time as the olivine. The apatite occurs in stumpy and also in long crystals many of which measure 3 millimetres. A little red biotite, apparently secondary, occurs about the borders of the magnetite grains and in and about the olivine crystals. Much of this mineral has been altered to pale green chlorite.

Age

The Abana dyke resembles dykes which in eastern Ontario have been proved to be older than the Cobalt series.[1]

The Abana dyke does not seem to have suffered east-west faulting, whereas the northeasterly trending quartz diabase and olivine diabase dykes have apparently been displaced by faults some of which may strike southeast. This not very reliable evidence indicates that the Abana and, presumably, the other north-south dykes are younger than the northeast-

[1]Cooke, H. C.: Geol. Surv., Canada, Mem. 115, p. 33 (1919).
Miller, W. G.: Can. Min. Jour., vol. 44, p. 298 (1923).

erly trending quartz diabase dykes. That the north-south dykes are the younger is further indicated by the fact that in one locality, as reported by Mr. J. J. Caty, manager of the Abbey Mines, Limited, a north-south dyke cuts a quartz diabase dyke striking northeasterly.

It may be that the fresher looking, olivine diabase dyke is younger than the quartz diabase dykes. This is the age relationship found for these two types of dykes in various parts of Ontario,[1] but there they are post-Cobalt in age.

The relative age of the olivine diabase to the north-south non-porphyritic dykes or Abana dykes is not known.

The following tentative age relationship of the various dykes is made, although it is admitted that the only two dykes whose relative age is known are the northeast-southwest quartz diabase dyke and the younger north-south non-porphyritic quartz diabase dyke. From older to younger they are: Abana dyke, quartz diabase dykes, north-south, non-porphyritic, diabase dykes, and olivine diabase dykes. Although put apart on petrographic grounds it is very probable that the Abana dyke and the north-south non-porphyritic dykes are of the same age. Also it may be possible that the olivine diabase dyke may be older than the north-south non-porphyritic dykes.

DESCRIPTIONS OF MINERAL PROPERTIES

ABANA MINES, LIMITED

The Abana Mines, Limited, controls 600 acres in the north part of Desmeloizes township, Quebec, comprising lots 44 and 45 and the south halves of lots 38 to 43 inclusive, range X, and the north halves of lots 46 and 47, range IX. A shaft has been sunk and most of the work done on the south half of lot 44. The mine is 11½ miles north of the village of Dupuy on the Canadian National railway. From Dupuy there is a good automobile road for 2½ miles, beyond which for 9 miles is a road good in winter but only fair in summer.

Up to the end of September, 1928, the shaft had been sunk 315 feet, about 1,800 feet of drifting and crosscutting had been completed on the 300-foot level, and stations had been cut at the 100 and 200-foot levels. Two thousand feet of diamond drilling had been done from the 300-foot level. Considerable trenching, chiefly on lots 44 and 45, had been performed, and a surface plant and various buildings built.

The property when owned by the Canadian Exploration Company of Amos, Quebec,[2] had been visited by the writer in October, 1925. Up to that date, work consisted of stripping and trenching. The main mineral showing was near the site of the present shaft.

The Abana shaft is on the eastern flank of a ridge extending northeasterly. The shaft lies half a mile from the top of the ridge. Northwest from the shaft the ground rises 90 feet in a distance of 700 feet, to the

[1]Collins, W. H.: Geol. Surv., Canada, Mem. 95, p. 101 (1917).
[2]Geol. Surv., Canada, Sum. Rept. 1925, pt. C, pp. 78-81.

southeast it falls 40 feet in the same distance. The surface in the immediate vicinity of the shaft, both up and down hill, is broken by gulleys. Above the shaft the gulleys are 10 to 15 feet deep, below some are 30 feet deep, and the surface, on the whole, is more irregular.

General Geology

Natural rock outcrops are confined to an area about 200 feet broad and extending west from the shaft for 600 feet. The drift over this area averages 2 to 5 feet in depth and consists of unassorted morainal material containing boulders up to 2 feet in diameter. East and southeast of the shaft, the drift cover increases in thickness until at 350 feet east of the shaft, it is probably thicker than 100 feet. At one place, 490 feet east-southeast from the shaft, the drift is more than 170 feet thick. Farther east the thickness decreases and in trenches situated 1,000 feet east-south-east of the shaft, the bedrock in places was reached at depths of 4 to 10 feet. The drift east of the shaft is a fine sand containing small quantities of clay. In places the sandy material is bedded.

The rocks exposed at the surface and underground, and revealed by diamond drilling, are Keewatin volcanics and associated sediments, feldspar porphyry dykes, a quartz-albite granite dyke, and a porphyritic quartz diabase dyke (the Abana dyke).

The volcanics are chiefly flows of fine-grained rhyolite and porphyritic rhyolite, but more basic varieties occur. The flows strike at 115 degrees and dip at probably 80 degrees to 85 degrees, to the north. From evidence gathered elsewhere, the flows are believed to face the south. The sediments recognized are mostly andesitic tuffs difficult to distinguish from sheared flows. Five hundred feet north of the shaft trenching disclosed small thicknesses of slate and impure quartzites, largely carbonated and replaced in varying degrees by fine-grained quartz much of which is closely associated with the iron-rich carbonate.

Over the limited area of natural outcrops extending west and south from the shaft, all the volcanic rocks are sheared and the sediments of the north end of the area are greatly sheared, so that they are in paper thin laminæ. The planes of shearing strike at 110 degrees to 126 degrees and dip at 80 to 85 degrees north.

The volcanics exhibit three types of alteration, sericitization, silicification and carbonatization, and chloritization. Sericitization is most widespread and is most marked in the strongly sheared rocks. These are very light coloured, have a silky lustre on cleavage faces, and in many places contain individuals of green chlorite 1 to 2 millimetres long. The rocks are very fine-grained, the grain being 0·01 to 0·03 millimetre. The content of the various minerals varies greatly. Quartz predominates, but wisp-like flakes of sericite occur nearly throughout the rock. The chlorite individuals have ragged ends and are clinochlore in many instances, replaced in part by quartz and calcite. Calcite is commonly present in considerable quantities. Rutile and iron ore occur in places. Sulphides are absent from most of the rock, but do occur near the ore deposits. This type of alteration is probably the most widespread near the ore-bodies.

Rocks affected by the above described type of alteration grade imperceptibly into others in which the chlorite content is high. In these rocks the chlorite occurs in radiating and in fine granular masses. Quartz, sericite, and carbonate occur in varying but subordinate proportions.

The effects of silicification and carbonatization are well displayed by the rocks in the crosscut extending north from the shaft and also, in varying degrees, by rocks found elsewhere. The schistose volcanics and sediments are replaced, in a varying degree, along the planes of schistosity, by elongated, lens-like bodies 0·5 to 5 mm. long, of fine-grained quartz and carbonate. Most of these lenses have a grain of 0·03 millimetre and consist of 50 per cent quartz and 50 per cent calcite with occasional flakes of chlorite. The lenses are sharply bounded against the enclosing sericite schist which, for the most part, is composed of about 80 per cent sericite, 10 per cent quartz, and 10 per cent chlorite with occasional cubes of pyrite.

Feldspar porphyry dykes cut the volcanics at various points. Ten narrow dykes, ½ to 2 feet wide, cut volcanic agglomerate 1,050 feet west of the shaft. The dykes strike 115 degrees and dip vertically. One dyke cuts the planes of shearing at an acute angle. The volcanics here are also partly replaced by materials from the porphyry, as is the case in an outcrop 200 feet west of the shaft. A diamond drill hole drilled at an angle of 45 degrees, southward from the 300-foot level a few feet east of the Abana dyke, intersected a section 200 feet wide containing five feldspar porphyry dykes, 1 to 6 feet wide, other similar dykes a few inches wide, and about 150 feet of fairly basic volcanics partly replaced by materials from the porphyry. In an outcrop bearing of 147 degrees and 1,700 feet from the shaft feldspar porphyry is exposed over a breadth of 70 feet. It contains shreds of greenstone and neighbouring greenstone is partly replaced by porphyry materials.

Although the feldspar porphyry dykes have sharply defined edges, they do not have chilled margins. The rock is porphyritic, the phenocrysts are 2 to 3 mm. in diameter, are of plagioclase feldspar and of quartz, and form about 45 per cent of the rock volume. The groundmass has a grain of about 0·03 millimetre and is composed of quartz, feldspar, and sericite, with some carbonate. The composition of the rock is about quartz 40 per cent, plagioclase 40 per cent, sericite 10 per cent, and calcite 10 per cent.

The quartz phenocrysts are euhedral or are rounded grains with in many cases crenulated margins and showing undulatory extinction. The feldspar phenocrysts are more abundant. Many show alteration to carbonate and sericite. The feldspar was determined to be albite in one specimen, basic albite in another, and acid andesine in a third. Sericite occurs in the groundmass in small, ragged, narrow flakes. Calcite occurs in irregular grains both in the feldspar and groundmass. The groundmass is a fine mosaic of quartz and, probably, feldspar and sericite.

The volcanics where they are replaced by materials of the porphyry grade in short distances into typical porphyry and typical volcanic rock. The added materials gave the volcanic rocks a porphyritic aspect. The pseudophenocrysts are poorly shaped plagioclase crystals containing inclusions of sericite and calcite. Irregular grains of quartz are also developed.

The rest of the rock is made up of varying proportions of chlorite, sericite, calcite, and minute grains of, probably, quartz and feldspar. The chlorite, in many cases, forms a considerable proportion of the rock. It occurs in irregular patches and irregularly radiating aggregates which with the calcite and small grains of quartz and feldspar form a mosaic filling the interspaces between the pseudophenocrysts of plagioclase and the larger, irregular quartz grains.

An altered, rusty-weathering, dark, quartz-albite granite dyke crosses the property with a strike of 140 degrees and a dip of 80 degrees to the north. It has a width of from 25 to 45 feet. In an outcrop 100 feet west of the shaft, the dyke cuts volcanic rocks partly replaced by materials from feldspar porphyry; the quartz-albite granite dyke is, therefore, younger than the feldspar porphyry. It cuts volcanics that have been replaced by materials from feldspar porphyry intrusions. It occurs on the 300-foot level on both sides of the Abana dyke and its positions on the two sides of the dyke are such as would have been produced by a fault causing a horizontal offset to the north of 220 feet. The quartz-albite granite dyke cuts the shearing planes in the volcanics at a slight angle. Although the dyke rock in places is slightly sheared it has not suffered as much shearing as the volcanics. Its intrusive nature is clearly shown in an outcrop just west of the shaft, where the sinuous nature of its boundaries and the existence of apophyses extending into the volcanics are clearly exposed.

The granite dyke varies in grain from about 2 to 0·2 mm. A specimen from the 300-foot level is composed of 40 per cent feldspar, 10 per cent quartz, 20 per cent chlorite, and 30 per cent carbonate. In thin sections the feldspar which has a euhedral tendency has a very dusty appearance owing to alteration products. It apparently is albite. Quartz forms some large grains, but most of it occurs in small grains. It also occurs in micrographic intergrowths. The chlorite is penninite and occurs in shred-like flakes containing numerous inclusions. Irregular plates and grains of a ferruginous carbonate are common. Small amounts of sericite, leucoxene, and pyrite are also present.

A porphyritic quartz diabase dyke known as the Abana dyke and which has been described in some detail on preceding pages, strikes north and south through the property and divides the mineral deposit into an east body and a west body. The chilling of the dyke against the ore is clearly shown on the 300-foot level. The west edge of the dyke bends around the pyrite-rich ore and is chilled for a width of 5 centimetres, whereas, nearby against the adjacent rhyolite the chilled edge is only 0·5 millimetre wide. Small offshoots of the dyke cut the sulphide body, are extremely fine grained, and are much lighter in colour than the main dyke. They seemed to have cooled very rapidly. At one place a tongue of pyrite 8 inches wide extends 3 feet into the dyke and is bordered by a narrow chilled margin of the diabase. The narrowness of the chilled margin at this place is explainable as due to the small volume of the pyrite tongue partly enveloped by the dyke—its chilling effect was bound to be small. Pyrite veinlets traverse parts of the dark margin near the ore and are believed to represent pyrite obtained by the dyke as it cut through the ore zone. There is no doubt in the writer's mind that the dyke cut the ore zone after its formation.

Two ore-bodies are present. Their major axes strike 122 degrees parallel with the shear planes of the country rock. The shaft is sunk on an outcrop very near the western end of the western ore-body. On the 300-foot level this body has a lenticular shape, is 400 feet long, and is widest, about 55 feet, at a point about 135 feet from its east end. The east end is blunt. The west part forks into two bodies at a point about 170 feet east of the end, the southern fork has an average width of 18 feet, the northern fork of 6 feet, and the two parts are separated, on an average, by 12 feet of unmineralized country rock. The north fork apparently wedges out gradually, whereas the south fork terminates bluntly with a sharp contact with the wall-rock.

From the evidence obtained at the surface, in the shaft, and on the 300-foot level it is evident that the western ore-body dips about 80 degrees to the north. A little mineralization is visible on the surface a short distance west of the shaft, is an upward extension of the mineralization seen on the 300-foot level, and indicates that the rake of the west end of the ore-body is probably vertical.

On the 300-foot level the west body has been explored by a drift in ore along the foot-wall and by five crosscuts at intervals of about 100 feet. This development clearly shows the west ore-body to be roughly banded and to be mineralized in various proportions with pyrite, sphalerite, galena, and chalcopyrite. This banding is not uniform along the strike, the bands rapidly changing in mineral content. Small slips and faults complicate the situation. The contact with the foot-wall is sinuous or rolling and along it for 230 feet from the west end of the body is a band varying in width from 3 to 12 feet and composed on an average of about 70 per cent sphalerite and 25 per cent pyrite, with small shreds of the wall-rock and small quantities of quartz, calcite, chalcopyrite, and, in places, a little galena. To the east the ore-body along the foot-wall consists of 10 to 50 per cent pyrite disseminated in rhyolite, with occasional patches high in pyrite or sphalerite.

The hanging-wall side of the western body on the 300-foot level is rich in chalcopyrite where crossed by the three westernmost crosscuts. This chalcopyrite-rich band in the two westernmost crosscuts forms the north branch of the forked ore-body. The width of this band in the three westernmost crosscuts is, from west to east, 1 foot, 11 feet, and 10 feet, respectively. The average chalcopyrite content is about 35 per cent, the rest of the mineralization being pyrite with, in places, minor quantities of sphalerite and shreds of the country rock. To the east in the remaining two crosscuts the chalcopyrite-rich band does not occur, its place is taken by rhyolite rich in pyrite. In the western of these two crosscuts the pyrite content across a width of 15 feet adjacent to the hanging-wall averages about 40 per cent; in the easternmost crosscut the pyrite content averages 20 per cent over a width of 16 feet.

In the westernmost crosscut 12 feet of unmineralized rock separates the copper-rich band along the hanging-wall from the zinc-rich band along the foot-wall. In the crosscut next to the east the hanging-wall band is separated from that along the foot-wall by 10 feet of unmineralized rock and 15 feet containing an average of about 40 per cent pyrite, 20 per cent chalcopyrite, and 5 per cent sphalerite. In the next crosscut to the east, the copper-rich hanging-wall band is followed by a 10-foot band containing about 60 per cent pyrite and 3 per cent zinc, and this by a band 30 feet wide containing a little irregularly disseminated pyrite forming not more than 5 per cent of the whole; the 30-foot band adjoins the zinc-rich band following the foot-wall. In the two eastern crosscuts the place of the three central bands is taken by a 25-foot band with a pyrite content that reaches 80 per cent or more and is accompanied by minor quantities of sphalerite present in patches in the leaner sections.

The mineralization seen in the shaft and at the 100- and 200-foot stations does not indicate any pronounced change vertically in the proportions of the various sulphides. Chalcopyrite and galena are more abundant relative to sphalerite and pyrite, but owing to the patchy distribution of the sulphides and the small widths exposed in the shafts and at the stations it is not thought that the variations in the content of the various sulphides are particularly significant.

The western ore-body is separated from the eastern by the north-south striking, diabase dyke (Abana dyke) which has a width of 200 feet. The eastern ore-body has the same strike as the western, but lies 50 feet north of it.

When studied by the writer, the east ore-body had been partly explored by a drift along the foot-wall and by two crosscuts at, respectively, 110 feet and 190 feet from its western end at the edge of the diabase dyke. Since then drifting and crosscutting have shown the eastern body to be longer than the western body. The pyrite-mineralized rock in the trenches about 1,000 feet east of the shaft is probably near the end of the east ore-body.

The eastern of the two crosscuts did not, at the time of the writer's visit, reach the hanging-wall. The mineralization in the western crosscut has a width of 34 feet and consists of 50 per cent to 60 per cent pyrite with a central section 8 feet wide, containing, in addition, 15 per cent sphalerite. In the eastern crosscut the body for a width of 22 feet from the foot-wall is solid pyrite and sphalerite, the sphalerite grading from about 15 per cent at the foot-wall to about 60 per cent with a little chalcopyrite 22 feet north of it. For the next 6 feet to the north, to the working face, the sphalerite content is 10 per cent and in the face of the crosscut an 8-inch stringer of chalcopyrite containing a little quartz was seen.

Specimens from the sphalerite-rich sections of the ore zones are banded, the bands are alternately rich in pyrite and sphalerite and they roughly parallel the trend and dip of the ore-bodies. The bands vary in width from a very small fraction of an inch to 3 inches. They lack definite boundaries and a mineral band grades, either rapidly or gradually, into the adjoining bands and also changes in composition along its strike. The grain of the minerals varies much, but commonly is from 0·5 to 2 millimetres in diameter, the pyrite being usually finer grained. The pyrite grains typically, but does not always show idiomorphic outlines.

The sphalerite usually forms a mosaic of allotriomorphic grains which on a surface etched with HCl and HNO_3 show a lamellar twinning. Irregular, small grains of chalcopyrite occur in many places along the boundaries of the twin lamellæ. Pyrite grains where scattered through the sphalerite show idiomorphic outlines. Irregular grains of quartz and calcite are common throughout the sphalerite. Irregular specks of galena are present in some cases in small quantities and, in most instances, are commoner around the quartz and calcite grains.

In one specimen grains of what is believed to be enargite were found, they contain blebs of chalcopyrite. These grains occur in sphalerite associated with galena. The colour of the mineral in reflected light is yellow-grey and the hardness about the same as sphalerite. To the following six re-agents it gave the following reactions: HNO_3 positive, slight brown tarnish, rubs clean; HCl, $FeCl_3$, NaOH all negative; and with KCN tarnishes iridescent. Owing to its appearance and to its reaction, the mineral is believed to be enargite rather than pyrrhotite which it slightly resembles.

The order of crystallization of the minerals of the sphalerite-rich ore —they are believed to have been formed during one period of mineralization—is: first, pyrite; second, sphalerite, chalcopyrite, and enargite; and galena largely third. There appears to be a time overlap of all these groups.

A specimen of 95 per cent chalcopyrite ore shows the following mineral content and relationships: small cubical pyrite in chalcopyrite and sphalerite; sphalerite with a grain of 1 to 2 millimetres contains bleb-like specks of chalcopyrite; irregular to rounded grains of pyrrhotite scattered throughout the chalcopyrite. A dark grey gangue mineral which is not a carbonate, but, probably, a silicate, is present in small quantities with the sphalerite and pyrrhotite aggregates. Chalcopyrite in irregular veinlets cuts the pyrrhotite and pyrite and apparently crystallized later than these two minerals. In various parts of the mine chalcopyrite was seen associated with glassy white quartz and occurred cutting the country rock. It was also found disseminated with the other sulphides in schistose phases of the country rock.

In some specimens of the sphalerite-rich ore, fragments of coarse, ferruginous carbonate are present and are veined by the sulphides. Fine-grained quartz and carbonate have the same relationship to the sulphides. In one specimen fine-grained, disseminated sphalerite replaces these fragments. Galena is commonly found near the margins of these fragments or penetrating deeply into them.

The order of mineralization in a general way seems to be carbonatization and silicification of the brecciated and sheared volcanics, later followed by the mineralization of this rock by the sulphides, the order of crystallization being in the order previously stated.

The feldspar porphyry is older than the quartz-albite granite dyke and both, apparently, are later than the main shearing suffered by the rhyolite and what seem to be fine tuffaceous sediments which jointly form the country rock of the ore-body. In places the rhyolite in and adjacent to the ore-body has suffered brecciation rather than shearing.

The localization of this brecciation may have been due to the buttressing effect of the quartz-albite granite dyke when later shearing forces were active. That there were later shearing forces acting at least on a small scale, is shown by the slight shearing of the margins of the quartz-albite granite dyke and of some of the volcanics where replaced by materials of the feldspar porphyry.

The sulphide mineralization was introduced before the 200-foot wide diabase dyke was intruded. Faulting along the course followed by this dyke divided in two the original single ore-body.

The sulphide deposit cannot be related to the later diabase dyke, but must be related to some other igneous body, probably the feldspar porphyry. Rocks similar to the feldspar porphyry are found as marginal phases of granitic masses within Desmeloizes area, as for example the Patten Creek granite mass, and in the vicinity of these intrusive masses sulphide deposits occur. Sulphide mineralization may, nevertheless, be related to the quartz-albite granite dyke which resembles the dyke in the vicinity of the Windsor mine ore-body some miles to the southeast.

BUSSIERE AND GAIGNON CLAIMS

In 1928 Bussiere and Gaignon held a group of claims comprising 300 acres and consisting of lot 1 and south halves of lots 2 to 5 inclusive, range VIII, Desmeloizes township. Two outcrops occur on this property. The southern of the two outcrops is near the south boundary of lot 1 and is a contact phase of the volcanics cut by small syenite dykes. The outcrop is probably close to the north edge of the granitic intrusive in west-central Desmeloizes township. The northern outcrop is on the west boundary, 2,500 feet south of the north boundary of lot 1. It is disclosed by 75 feet of stripping and rock trenching trending northeast. The rock is mainly a rhyolite, in places fairly strongly sheared in an east-west direction and with a dip of 85 degrees north. The rhyolite is cut at the north end of the exposure by a quartz diabase dyke of which only one side is visible. The contact trends southwest. Seven feet of the outcrop near its north end is 50 to 90 per cent coarse cubical and fine-grained pyrite, in irregular bands in the shattered rock. A little glassy almost colourless quartz is associated with the pyrite. South of this band is a width of 35 feet of slightly sheared rhyolite with a small content of pyrite and pyrrhotite. Odd specks of chalcopyrite were also seen. No quartz is present, but some chert-like, epidote-rich bands in the rhyolite may possibly have developed by silicification. South of this is a more basic sheared volcanic in which chlorite as well as other alteration products such as epidote and white mica have developed. Near the pyrite-rich band, joint-planes in the diabase dyke within 10 inches of the contact have pyrite along them and it is believed that this pyrite was derived from the mineralized zone which is older than the dyke.

It is doubtful if this sulphite mineralization contains an appreciable quantity of the precious metals nor was there any evidence that the low copper content might increase along the strike or down the dip of the mineralized zone.

ABONDE MINES, LIMITED

Abonde Mines, Limited (134 King Street East, Toronto), holds 200 acres in Desmeloizes township, comprising the south halves of lots 42 to 45 inclusive, in range IX. Work on this property was started in the autumn of 1927. An electrical survey was carried out by the Radiore Company of Canada during the following winter. Up to the end of September, 1928, considerable stripping, 500 feet of trenching, and about 2,500 feet of diamond drilling had been completed.

Rock outcrops within the limits of the property occur in a zone 1,000 feet wide and stretching across the property from the centre of the west boundary of the south half of lot 42 to near the southeast corner of lot 45. In lot 42, low outcrops form not more than 15 per cent of the zone. In lot 43 there are several small outcrops. In the east part of lot 44 and in lot 45 there is a large continuous outcrop, 1,200 feet long and 600 feet wide, separated from the outcrops to the west by a 600-foot wide, sand-filled valley.

The exposed rocks are Keewatin volcanics with minor amounts of sediments. The volcanic flows vary in composition, but are mostly andesites. They strike about 110 degrees and dip about 80 degrees to the north. It is believed but not proved that the tops face south. Minor amounts of tuffs and conglomerates are interbedded with the volcanics in beds a few feet wide. A 4-foot band of conglomerate containing granite pebbles was seen in the large eastern outcrop and has been discussed elsewhere in this report. A band of iron formation, 6 inches wide and associated with 4 feet of sediments some of which contain pebbles of volcanic rock, also occurs in this outcrop. A couple of irregular, altered lamprophyre dykes cut the volcanics. One of these dykes attains a width of 6 feet. In the large, continuous outcrop, and in other outcrops, the volcanics along narrow, ill-defined zones are partly replaced by feldspar. The replacement is like that described as occurring on the Abana property and is related to intrusions of feldspar porphyry.

The Abana diabase dyke, approximately 200 feet wide and striking about north, crosses the property. It does not outcrop, but its presence has been proved by diamond drilling. It enters the property from the north at, probably, a little west of the centre of lot 44 on range line IX-X. It is covered by 80 to 90 feet of sand containing a few boulders and lies 300 feet west of the large eastern outcrop.

No mineralization of economic interest has so far been found on the property. A few valueless, glassy quartz veins and narrow, silicified, and carbonated shear zones carrying pyrite were noticed.

DEMARA MINES, LIMITED

The Demara Mines, Limited, of Montreal, hold, in Desmeloizes township, 900 acres, consisting of lots 35 to 41 inclusive, the south halves of lots 42 and 43, range IX, and the south halves of lots 36 and 37, range X. The property was intensively prospected during the winter of 1927 and the spring and summer of 1928. About 5,000 feet of trenching, 2,000 feet of diamond drilling, and a magnetometer survey of the greater part of the property were carried out. A large proportion of the drift-covered areas was also sounded to determine the depth of the bedrock surface.

The part of the property lying in the south half of range IX contains 80 per cent of the rock outcrops present. They form, probably, a fifth of the area of this part of the property and occur mostly in the form of areas many of which have diameters of 500 to 700 feet. Many smaller outcrops are also present. A rocky belt occurs in the south half of range X and in the north part of the south halves of lots 41 and 43, range IX. On the south boundary on the property, on the south boundaries of lots 37 and 38, are two outcrops. The south half of range IX is a flat sand-plain with areas of spruce muskeg.

The exposed rocks are mainly Keewatin volcanics and lie about 4 miles from the three large granitic masses in this part of the area. The volcanic flows show practically no shearing, are largely andesitic, and in many parts are well pillowed. Some rhyolite flows and some rocks of gabbroidal texture and composition which are apparently also flows are present. The rocks strike about 115 degrees and the dip is generally about 80 degrees to the north. The flows are believed to have their tops facing south. Interbedded with the flows is a large quantity of both fine and coarse tuffs, usually very little sheared. The series of outcrops near the central part of the property indicate that over a distance of 2,000 feet across the strike, almost half of this width is probably composed of tuffaceous rocks in beds from 3 to 80 feet thick and interbedded with flows 6 to 40 feet thick. Within a zone of this tuffaceous material, at the southern margin of the 2,000-foot wide belt, occurs banded iron formation which has been traced diagonally across the property.

Narrow hornblende lamprophyre dykes, usually branching and in many cases very irregular, appear in many outcrops. They seem to occur in greatest number in the central part of the north half of lot 39, range IX. Narrow diabase dykes outcrop, at the north boundary of lot 35, range IX, the north part of lot 40, range IX, and on lot line 38-39, range line VIII-IX. The dyke at the last-mentioned locality is 12 feet wide, strikes north 30 degrees east, and contains large greenish phenocrysts. The Abana diabase dyke is believed to pass under the drift-covered area on the east boundary of the property in the east part of lot 43. Dip needle readings taken on this part of the property seem to confirm this supposition.

Sulphide mineralization was noticed in two places: near the east boundary of lot 41, range IX, 600 feet from its north boundary; and in the centre of lot 40, range IX, 1,400 feet from its north boundary.

The northern occurrence is disclosed in two trenches which cut across the strike of the mineralization and are 70 feet apart. The mineralization occurs in a strongly sheared band, 8 feet wide, of what may have been a fine-grained tuff. The shearing strikes 117 degrees and dips 80 degrees north. South of this sheared band is a fine-grained rhyolite flow strongly sheared and carbonated. The northern 5 feet of the mineralized zone is composed of about 50 per cent quartz and ferruginous carbonate which have replaced the rock along its shearing planes. Quartz predominates, is a greyish glassy variety in part almost opalescent, and it occurs in thin, irregular sheets varying in width from paper thin to half an inch. Between these sheets, darker bands of rock hold 5 to 10 per cent of pyrite and magnetite in about equal quantities and in grains of not more than 2 millimetres in diameter and strung out in the direction of the banding. In one place a veinlet of pyrite 1 millimetre wide cuts across the banding. The southern 3 feet of the mineralized zone is cut by veins, ranging from a fraction of an inch to one foot in width, of glassy, white quartz. The smaller veins carry coarse, irregular grains and lenses of pyrite. Many of the veins cross the planes of shearing.

The southern mineral occurrence is exposed by surface trenching at one point and has been penetrated by four diamond drill holes spaced along a length of 800 feet. The strike of the gossan-stained zone is 113 degrees and the dip is 85 degrees north. The rocks are an assemblage of flows, volcanic fragmentals, and tuff with a little slaty iron formation. The rocks are sheared, but not as much so as in the northern mineral occurrence.

The best exposed section of the mineralized rock shows from north to south across the strike the following succession: 2 feet of a gossan-stained fragmental rhyolite mineralized with pyrrhotite; 16 feet of fragmental rhyolite cut by a 3-inch chloritized lamprophyre dyke; 3 feet of fragmental rhyolite, and 16 feet of shattered rhyolite, both gossan-covered and mineralized with pyrrhotite; 2 feet of slaty iron formation; volcanics and fragmentals cut by a few narrow lamprophyre dykes. The rock of the two gossan-stained zones, respectively 2 feet and 19 feet wide, is sheared and shattered and holds not more than 5 per cent of pyrrhotite which occurs in paper thin streaks, as disseminated irregular grains, and, in places, as lens-like veins 2 inches wide and even up to 1 foot wide or in zones 2 to 12 inches wide and composed of varying proportions of quartz, carbonate, and pyrrhotite. A few of the lens-like veins and zones merge along the strike into glassy quartz veins. Chloritic and micaceous materials are associated with the quartz-carbonate zones. In places a little distance from the mineralized rock, considerable biotite is present.

DESMELOIZES EXPLORATION SYNDICATE

The Desmeloizes Exploration Syndicate has done work on three groups of properties in Desmeloizes township. One group comprises 200 acres composed of the north halves of lots 2 to 5, range VIII. On this group are outcrops of andesites cut by a quartz diabase dyke. No mineralization of value is visible.

The other two groups comprise lots 38 to 40 inclusive and lots 43 to 44 inclusive, range VIII. Large rock outcrops form 50 per cent of the area of the western of these two groups and a smaller percentage of the south half of the area of the eastern group. The outcrops are separated by spruce muskegs and drift and clay areas. Most of the exploratory work has been done on the eastern of these two groups. It was carried out in 1927 and 1928 and included some trenching and diamond drilling.

The outcropping rocks are massive volcanics mostly andesites. In the centre of range VIII, on lot line 43-44, is an outcrop of the north-south striking Abana diabase dyke. On the southern part of the eastern group coarse gabbroidal rocks strike parallel with the volcanics or at about 120 degrees and dip about 70 degrees north. These coarser rocks may be intrusives, but probably are volcanic flows.

On lot 43, 700 feet from the south boundary, a 15-foot band of sheared basic tuff lies between gabbroidal bands respectively 80 and 50 feet wide. A 2-foot band in the tuff band, exposed over a length of 50 feet, appears to be silicified tuff and contains a little disseminated pyrrhotite and closely associated chalcopyrite. A narrow dyke of rhyolite cuts the tuffs and a similar dyke cuts the adjacent gabbroidal rock. The silicification and mineralization may be related to these dykes. Diamond drilling did not penetrate mineralization at depth.

LAVAL QUEBEC MINES, LIMITED, AND ALAMAC MINES, LIMITED

The Laval Quebec Mines, Limited, hold the mining rights on 600 acres in Desmeloizes township, comprising the south half of lot 47, lots 48 to 51, range IX, north half of lot 50, and lot 51, range VIII. The Alamac Mines, Limited, own the mining rights on 400 acres in Desmeloizes township, comprising the south halves of lots 46 to 53, range X, immediately to the east of the property controlled by the Abana Mines, Limited. Work on these two properties was done under one management in 1927 and consisted of an electrical survey, considerable trenching, and some diamond drilling. Most of this work was done on the south half of lot 46, range X, on the strike of the Abana mineral zone.

The properties are in an area presumably underlain by volcanics, but are almost completely covered with clay under which there is probably considerable morainal material. The few rock exposures are confined to the vicinity of range line VIII-IX, lots 50 and 51. The rocks in these outcrops are sheared, unmineralized andesites. The shearing strikes about 120 degrees and dips about 80 degrees to the north.

Trenching was also done just west of lot line 45-46, 600 feet north of range line IX-X, on the Abana property, and disclosed sheared and altered volcanics containing little or no sulphide mineralization.

LA REINE MINE, LIMITED

La Reine Mine, Limited, organized in 1927, has carried out work on a group of claims consisting of the north half of lots 25 to 28 inclusive, range V, and the south half of lots 23 to 31 inclusive, range VI, Desmeloizes township. Most of the work has been on the south half of lots 25 to 28, range VI, and consists of an unknown amount of diamond drilling and several thousand feet of trenching and stripping. The property is easily reached by good roads and is 6 miles from La Reine station.

Except for outcrops extending 2,000 feet along range line V-VI, in lots 25 to 28, and reaching 1,000 feet north, the property is covered with drift. The southwest part of the area of outcrop is underlain by granite and hornblende and biotite schists. Bands carrying garnet and schists high in graphite are present. The schistose assemblage is banded and much contorted, but has a general northwest strike. Sections of the schist are rich in iron carbonate and have rusty outcrops. The rocks were probably basic volcanics and tuffs. In places sulphides occur associated with small, irregular stringers of glassy quartz. The richest mineralization seen occurs in graphitic schists or slate in trenches on lot 25, range VI. The sulphides noted were pyrite with a little chalcopyrite and, in places, galena and sphalerite. Over widths of 2 or 3 feet the mineralization did not amount to more than a few per cent.

GERMAIN CLAIM

In lot 48, range VIII, La Reine township, about 700 feet south of range line VIII-IX, mineralization is exposed in a trench 40 feet long. The trench and a few strippings in its vicinity were made by Mr. J. E. Germain of Dupuy, owner of the claim on which they are situated.

The trench is about 100 feet east of the north-south striking quartz diabase Abana dyke. The rock exposed in the trench is sheared and carbonated rhyolite cut by narrow feldspar porphyry dykes. What appear to be highly altered tuffs, now biotite-hornblende schists, are also present. The dykes and the banding of the rocks strike 145 degrees and dip vertically. The trench runs at about right angles to the banding and in a space of 25 feet there are five mineralized zones from a few inches to a foot and a half in width. The mineralization consists of disseminated fine-grained pyrite. A few specks of sphalerite were also seen. Narrow veinlets of glassy quartz are associated with the sulphide.

A mile east of the trench are outcrops of a granitic mass. The feldspar porphyry dykes disclosed in the trench are offshoots of the granite body. The mineralization is probably related to the granitic rock.

PROSPECT IN LOT 39, ON RANGE LINE VI-VII, LA REINE TOWNSHIP

A little work, including some diamond drilling, was done in 1927 on an outcrop about 1,000 feet long east and west and 400 feet wide north and south in lot 39, range line VI-VII, La Reine township. The andesite is comparatively massive and is cut by two small syenite dykes, respectively 6 inches and 3 inches wide, striking 120 degrees and dipping 50 degrees north. Narrow, glassy quartz veins $\frac{1}{4}$ to 1 inch wide and 1 foot to 50 feet long, traverse the andesite. Associated with the veins and in the adjacent country rock is a little pyrite in cubes and also a little pyrrhotite.

CLERMONT MINING SYNDICATE

The Clermont Mining Syndicate holds 650 acres in Clermont township, consisting of lots 24 and 25 and the south halves of lots 27 to 30 inclusive, range VIII, and the north halves of lots 27 to 31, range VII. The property is easily reached from La Sarre village by wagon along a road 7 miles long to lot 32, range line II-III, and from there north by a good portage trail over sandy country for a farther distance of 6 miles.

Rock outcrops are confined to the south parts of lots 29 and 30, range VIII. The rest of the property is covered by clay and morainal material. In the rocky area 500 to 700 feet north of range line VIII and most in lot 30, considerable stripping and trenching have disclosed what are apparently three distinct mineralized zones. The northwesternmost zone strikes 140 degrees and is exposed in pits and trenches over a length of 225 feet. The second zone, as now disclosed, commences 340 feet east and 50 feet south of the easternmost pit of the first-mentioned zone, it strikes 110 degrees and has been exposed at intervals for 170 feet. The third zone lies south of and parallel with the second zone and has been intermittently exposed for a length of 280 feet west-northwest from a point 140 feet south and 30 feet east of the westernmost working on the second zone.

The rocks exposed in the vicinity of the mineralized zones are shattered or fairly strongly sheared volcanics. The northwesternmost zone and the west end of the southernmost zone are in altered andesite, the rest of this zone and the parallel zone to the north are in altered rhyolite.

Two vertical dykes striking 148 degrees and 2 and 3 feet wide, cut the volcanics. The dykes are sheared and hold much iron carbonate. They are dark green; phenocrysts of feldspar are recognizable, and also small phenocrysts of quartz. The dyke rocks are probably granodiorite and are presumably related to the Clermont granodiorite mass whose south edge is about 1½ miles to the north. Cutting across the dykes, but not entering the wall-rock, are two glassy quartz veins respectively 8 inches and 1 inch wide.

Although the trend of the westernmost mineralized zone is 140 degrees and that of the other two zones is 110 degrees, the strike of the mineralized bands composing the zones is between 100 degrees and 108 degrees and the dip is from 75 degrees north to 75 degrees south. The trend of the zones is at least in part due to step faulting. The width of the northwestern zone varies from 1 to 3 feet at the ends as now exposed, to 6 feet in the central section. The northern of the two eastern zones varies in width from 3 to 12 feet and the southern zone from 1 foot to 6 feet.

The zones, in addition to their sulphide contents, are in some parts composed of colourless to bluish quartz or of quartz with some carbonate in irregular masses and veinlets; in other parts, carbonate is more abundant than quartz. In places, the carbonate forms a selvage to the quartz veins and in some places the country rocks, especially the more basic, hold much carbonate for considerable distances from the mineralized zones. In the southern of the two eastern zones glassy white quartz containing veinlets of tourmaline and shreds of carbonated rock is present.

Sulphide mineralization is alike in all three zones and consists of varying quantities of pyrite and smaller quantities of galena, sphalerite, and chalcopyrite in this general order of relative quantities. The southern of the two eastern zones is richest in the three last mentioned sulphides, which over narrow widths in places form as much as 20 per cent of the zone.

A study of polished sections indicates that pyrite in irregular and euhedral grains up to 6 mm. in diameter crystallized first. It was followed by chalcopyrite and sphalerite in irregular grains up to 4 mm. in diameter and their period of crystallization was overlapped by that of galena in irregular grains, which continued to form after deposition of chalcopyrite and sphalerite had ceased. Quartz is associated with the sulphides and, probably, was both contemporaneous with and later than them. Many minute blebs of chalcopyrite lie along twinning planes in the sphalerite and irregular inclusions of this mineral and of galena are common in the sphalerite.

According to assay sheets shown to the writer by Mr. Dion, the manager of the property, appreciable amounts of silver and gold are present.

WINDSOR MINES, LIMITED

The Windsor Mines, Limited, have the mining rights on 800 acres comprising lots 44 to 51, range IX, La Sarre township. The property is easily reached from La Sarre village by 5 miles of good road. Work has been done on this property since 1926. Up to the time of visiting the property in September, 1928, considerable trenching, some test pitting, and some diamond drilling had been done.

Rock outcrops form about 15 per cent of the area and are most abundant in the eastern part. The development work has been largely confined to an area 500 feet square on the west boundary of lot 50 about 1,700 feet from its north boundary.

The rocks are volcanics with a little interbedded tuffaceous sediments. The rocks strike about 125 degrees and dip 80 degrees to the north. The rocks in places are massive and in other places are strongly sheared. Cutting through the area most closely prospected is a granite dyke about 150 feet wide; it is exposed in a few outcrops and apparently has a strike of 120 degrees and a vertical dip. The rock of the dyke has a slightly porphyritic texture and a grain of about 3 millimetres. The quartz and ferromagnesian content is low. Disseminated particles of pyrite are common.

Trenching commencing near the south margin of the dyke has disclosed a sulphide zone 90 feet long, 7 feet wide in the centre, and narrowing to nothing at the two ends. The strike of the body is 140 degrees and the dip 80 degrees to the north. It occurs in sheared, slaty, fine-grained tuffs apparently lying in a fold pitching in the direction of the strike of the sulphide body. The fold probably has caused the localization of the mineralization. The northwest end of the sulphide zone is against the south boundary of the granite dyke which strikes 105 degrees.

Sulphides in most places compose about 60 per cent of the zone and in places form nearly solid masses. A sample of the central massive part of the zone consists of 70 per cent pyrrhotite, 20 per cent chalcopyrite, 5 per cent pyrite, and 5 per cent sphalerite. In other sections the pyrite content is the most important and the chalcopyrite is less abundant.

The order of crystallization in a pyrrhotite-rich specimen was seen in polished sections to be: first, pyrite and pyrrhotite; pyrrhotite continued to crystallize later than pyrite and overlapped the contemporaneous crystallization of the chalcopyrite and sphalerite.

On the north margin of the granite dyke, north of the sulphide body described, stripping discloses rocks like those to the south, strongly sheared parallel with the dyke and containing a zone about 9 feet wide which has been replaced to some extent by quartz and carbonates. Sulphides in stringers and disseminated grains occur over a length of about 100 feet and a width of about 10 feet. The sulphides are chiefly pyrite, but pyrrhotite, chalcopyrite, and sphalerite also occur.

MELNOR GROUP

The Midland Base Metals Corporation holds a group of twenty-six unsurveyed claims north of Desmeloizes township, known as the Melnor group. The numbers of these claims are 20540, A20565 to 20568 inclusive, A20570 to A20589 inclusive. The group comprises about 900 acres and is about a mile east of the Ontario-Quebec boundary and a mile north of the north boundary of Desmeloizes township. The claims are reached by a trail going north from lot 14 on the north boundary of the township. Considerable trenching has been done on the property.

Outcrops are few and most are of andesite, but some are rhyolite. The south edge of the Patten Creek granite mass passes along the north boundary of the claims. A few pegmatite and aplite dykes cut the volcanics. A little pyrite, in many cases associated with quartz, occurs in outcrops of the sheared volcanics. So far no mineralization of value has been found.

AURION GROUP

The Aurion group consists of seventeen unsurveyed claims having an area of about 700 acres and lying between the Melnor group and the north boundary of Desmeloizes township. The numbers of the claims are A20531-A20539 inclusive, A20541-A20546 inclusive and A20548-A20549 inclusive. Considerable trenching has been done chiefly on claim No. A20542. The area is heavily drift covered, but as indicated by the outcrops is underlain by volcanics, chiefly basic. A few feldspar porphyry dykes are present. Trenching has disclosed strongly sheared volcanics heavily mineralized with carbonate cut by quartz stringers, and with pyrite disseminated over narrow widths. A little magnetite occurs in places.

RADNOR MINES, LIMITED

The Radnor Mines, Limited, holds two groups of claims north of Desmeloizes township. The west group of about 400 acres comprises a block of ten claims, Nos. A16439 to A16448 inclusive, lying one mile north of the north boundary of Desmeloizes township and 2 to 3¼ miles east of the Ontario-Quebec boundary. The east group of fifteen unsurveyed claims comprises about 600 acres and forms a compact block about a mile in diameter, whose centre is about 1¾ miles north of the north boundary of Desmeloizes township at lot 36. The west group is reached by a portage trail west from the Arno trail. The Abana-Altura road passes through the west part of the east group.

Radiore surveys have been made of the drift-covered east part of the west group and of the west part of the east group which, also, is practically covered by drift.

A series of outcrops in the central and southern parts of the western group are chiefly of rhyolite, cut by a few feldspar porphyry dykes. In the west part of the eastern group are outcrops of somewhat altered andesites and rhyolites. No mineralization of economic importance was seen.

UPPER AND LOWER ARNO CLAIMS

Arno Mines, Limited, formerly known as the National Base Metal Corporation,[1] hold two groups of surveyed claims north of Desmeloizes township, known as the Upper and Lower Arno claims.

The northern or Upper Arno group consists of a block of fifteen claims having an area of about 600 acres located 2½ to 3½ miles east of the Ontario-Quebec boundary and 1¾ to 2¾ miles north of the north boundary of Desmeloizes township. This group comprises claims Nos. A16434 to A16438, inclusive, and A16449 to A16458 inclusive. The southern or Lower Arno group comprises an irregular block of sixteen claims of about 600 acres. The southwest corner of the group touches the north boundary of Desmeloizes township at lots 29 and 30. The group is 1½ miles long, north and south, and has a maximum width of ¾ mile. The numbers of these claims are A18740, A18751 to A18755, and A16981 to A16990.

The properties are reached by a winter trail from the Abana mines at distances of 5 and 3 miles respectively.

Work on the property was begun in August, 1927. An electrical survey was made of parts of both groups by the Radiore Company of Canada in the autumn and winter of 1927 and 1928. Diamond drilling has been carried out on the Lower Arno group and by August 15, 1928, amounted to 4,000 feet. Some trenching has been done, chiefly on the Upper Arno group.

On the Upper Arno group 25 per cent of the area is rock outcrop. The group just includes the southwest margin of the Patten Creek granite mass. The rest of the area is underlain by volcanics which strike east and west and have a vertical dip. They are believed to face south. All the volcanics have suffered contact metamorphism and in places are sheared along an east or slightly north of east direction. The volcanics of the northern part are mainly basic, those in the southern part are rhyolites. Narrow feldspar porphyry, granite, and aplite dykes cut the volcanics. A quartz diabase dyke, striking north, cuts the eastern part of the group. The electrical survey detected fifteen electrical conductors in the east part of the group. Trenches and outcrops show that many of these are shear zones mineralized with sulphides. The zones, as disclosed by the work done, are from a few inches to 10 feet wide and carry disseminated pyrite in amounts varying from 5 to 20 per cent. Very small amounts of pyrrhotite and chalcopyrite were noticed.

[1] "Progress in the Development of the Mineral Deposits in Western Quebec during 1927," p. 61.

On the Lower Arno group very little rock is exposed. The few outcrops and the results of diamond drilling indicate that the claims are underlain by rhyolite. Much of the rhyolite is sheared and altered to talcose schists. The electrical survey indicated twelve conductors in the eastern part of this property. Diamond drilling disclosed zones of disseminated sulphide having widths of 2 to 30 feet. The sulphides are pyrite, pyrrhotite, and chalcopyrite associated for the most part with glassy quartz and carbonate. Silicification of the rock was not noticed in the vicinity of the mineralization seen.

ALTURA CLAIMS

A group of fifteen surveyed claims, known as the Altura group and having an area of about 600 acres, are situated about 4 miles north of the north boundary of Desmeloizes township and about 5 miles east of the Ontario-Quebec boundary. The numbers of the claims are A22652 and A19067 to A19080 inclusive. The claims are easily reached by a good trail, 5½ miles long, north from Abana mines. Considerable work has been done on this property, consisting in part of trenching, 3,900 feet of diamond drilling up to October, 1928, and the sinking on claim No. 19076 of a prospect shaft 47 feet deep.

The east edge of the Patten Creek granite mass passes north and south through the westernmost claims. The rest of the property, over which considerable rock outcrops, is underlain by highly altered rocks, chiefly basic volcanics with some volcanic fragmentals. The fragmental rocks are in large part altered to hornblende and garnet rich rocks. Their bedding in most places strikes north or slightly west of north. On the whole the rocks are not highly sheared. Feldspar porphyry pegmatite and aplite dykes are common. A few narrow lamprophyre dykes and a 6-foot diabase dyke were seen. Quartz veins occur.

The chief mineral showings are on claims A19076 and A19079, on the former a shaft has been sunk. The western parts of these two claims are underlain by granite. The mineralization consists of sulphides, chiefly pyrite, with some pyrrhotite, some magnetite, a little chalcopyrite, veins of glassy quartz garnets, chlorite, epidote, and hornblende. The widest mineralized zone seen is 6 feet wide and in it the sulphides are disseminated in small amounts. The minerals present indicate a deposit formed at high temperature.

ABBEY MINES, LIMITED

Abbey Mines, Limited, hold two groups of claims in Desmeloizes township known as No. 1 and No. 2 groups. No. 1 group comprises the north half of lots 38 to 43, range X, Desmeloizes township, and also surveyed claims Nos. A9715 to A9719 lying north of the lots and unsurveyed claims Nos. A4146-A4150 to the northwest of the lots. No. 2 group consists of the south half of lots 16-19, range X, and the north half of lots 16-19, range IX, Desmeloizes township. The two groups are respectively of about 700 and 400 acres.

The work done on No. 1 group includes a radiore survey, about a thousand feet of trenching, and about 10,000 feet of diamond drilling. Little work has been done on No. 2 group except for an electrical survey.

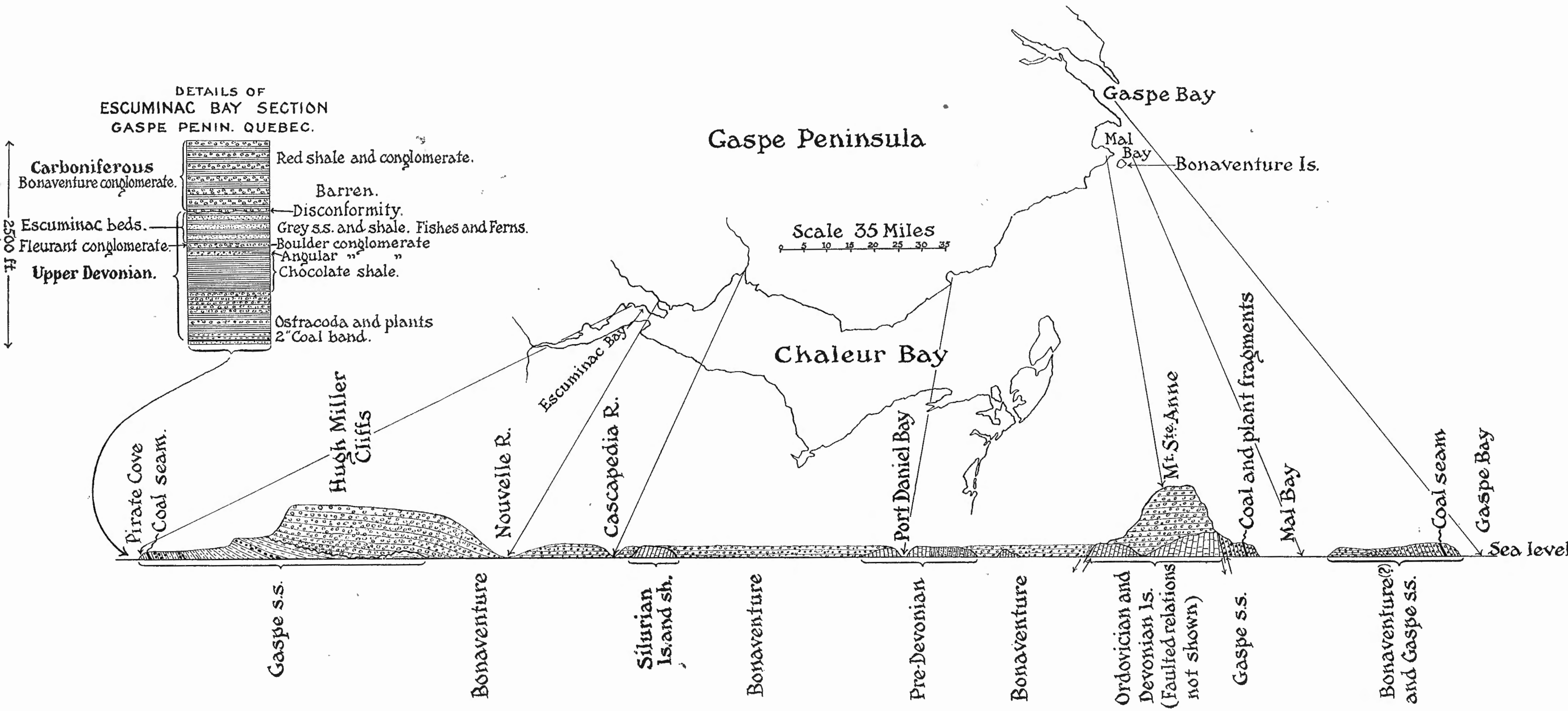
Group No. 1 is largely covered with drift, but outcrops are numerous. Except along the southern margin of the property, the underlying rock is rhyolite more or less sheared. In lots 40 and 41, 2,000 to 2,500 feet south of their north boundaries, trenching discloses the 40-foot quartz-albite granite dyke seen on the Abana property to the south. It strikes about 25 degrees north of west. This dyke and adjacent basic volcanics are highly carbonated.

The electrical survey indicated the presence of a number of conductors. The strike of these conductors is about 20 degrees north of west and parallels the schistosity of the rocks. Extensive diamond drilling carried out on some of these conductors discloses zones of sulphide mineralization varying in width from a few feet to 50 feet. Some of these zones are a few hundred feet long. The sulphides consist mainly of pyrite in quantities varying in different parts of these zones from a few per cent to 60 per cent. A little sphalerite, chalcopyrite, and occasional specks of pyrrhotite are present. Assays of the better parts of these mineralized zones show the zinc and copper contents to be fractions of a per cent. Traces of silver are reported in the assays.

On No. 2 group only one outcrop was seen. It is in the northwest corner, and is a quartz diabase dyke striking northeast. The nature of the bedrock on this group is not known, but it is probable the rocks are volcanics.

ABACO SYNDICATE

The Abaco syndicate holds twenty-one unsurveyed claims having an area of about 800 acres and situated north of Desmeloizes township. Their south margin is the north boundary of the township between lots 42 and 50. The numbers of the claims are A15235 to A15240 inclusive, A20590 to A20599 inclusive, and A22923 to A22927 inclusive. The area of the group is largely drift covered. A few outcrops of altered andesite were seen near the western margin of the group. Two thousand feet of diamond drilling has been done on the property and the Radiore Company have also made an electrical survey. So far no mineralization of economic importance has been discovered.


DETAILS OF
ESCUMINAC BAY SECTION
GASPE PENIN. QUEBEC.
Carboniferous
Bonaventure conglomerate.
Red shale and conglomerate.
Barren.
Disconformity.
Escuminac beds.
Grey s.s. and shale. Fishes and Ferns.
Fleurant conglomerate.
Boulder conglomerate
Angular " "
Chocolate shale.
Upper Devonian.
2500 ft.
Ostracoda and plants
2" Coal band.
Gaspe Peninsula
Gaspe Bay
Mal Bay
Bonaventure Is.
Scale 35 Miles
0 5 10 15 20 25 30 35
Chaleur Bay
Escuminac Bay
Pirate Cove
Coal seam.
Hugh Miller Cliffs
Nouvelle R.
Cascapedia R.
Port Daniel Bay
Mt. Ste. Anne
Coal and plant fragments
Mal Bay
Coal seam
Gaspe Bay
Sea level
Gaspe s.s.
Bonaventure
Silurian ls. and sh.
Bonaventure
Pre-Devonian
Bonaventure
Ordovician and Devonian ls. (Faulted relations not shown)
Gaspe s.s.
Bonaventure(?) and Gaspe s.s.

STRATIGRAPHIC RELATIONS OF THE UPPER DEVONIAN BEDS AND THE BONAVENTURE CONGLOMERATE, AT ESCUMINAC BAY, QUEBEC

By E. M. Kindle

Illustrations

INTRODUCTION

Escuminac bay is a bight in the north shore of Chaleur bay opposite the town of Dalhousie, N.B. It is a locality well known to geologists as the source of a unique fish fauna of Upper Devonian age. Towering above the beds with the entombed fishes a half mile back of the seashore are the bright red cliffs of Bonaventure conglomerate which the late Dr. J. M. Clarke very appropriately named the Hugh Miller cliffs in memory of the Scottish geologist who did so much to make known the fossil fish of the Old Redstone sandstone of Scotland (Figure 3).

Another set of beds lying a few hundred feet below the fish beds have, because of their dull red or chocolate colour, sometimes been confused with the Bonaventure formation. These beds which belong in the lower part of the Upper Devonian section are of unusual interest on account of the coal seam which they include and the fossil plants associated with it which have not previously been brought to the notice of geologists. This seam, though very thin and occurring below the horizon to which coal is ordinarily limited elsewhere, is shown by the analysis given in this paper to be a coal of good quality. The sediments at Escuminac bay, with the thin coal and fossil plants near the base and fishes higher up, are located more than 100 miles west of the type area of the Gaspe sandstone in which Sir Wm. Logan more than 60 years ago reported a thin seam of coal.

It is proposed in this paper to consider the correlation and delimitation of the formations at Escuminac bay, which include the red conglomerate of the Hugh Miller cliffs, and the fossil-bearing beds below, in the light of a critical review of the type section of the Bonaventure conglomerate at Bonaventure island.

ESCUMINAC BAY SECTION

The oldest beds to be considered here outcrop along the shore southeast of a brook mouth that enters the head of Pirate cove about half a mile east of the Escuminac Flats schoolhouse. The Escuminac Bay shoreline shows nearly continuous bedrock exposures from Pirate cove to Yacta point. The shore section and Hugh Miller cliffs overlooking Escuminac bay include the following sediments beginning with the oldest beds:

	Feet
A. Angular-pebble conglomerates interbedded with chocolate, green, and grey, argillaceous and sandy shales. Lower beds characterized by an ostracode fauna and numerous plant fragments, the latter closely associated with a vein of coal 2¼ inches thick. (Southeast of A. Mackenzie's residence head of Pirate cove. Beds largely covered)	400±
B. Coarse, angular-pebble conglomerate with salmon coloured matrix	210
C. Coffee coloured shale (dull red wet) with occasional green bands. Upper part with a conglomerate member 0 feet to 40 feet. (C1) Lower part of formation partly concealed. Barren of fossils. (Both sides mouth of Englishman creek)	450
D. Coarse, rounded pebble and boulder conglomerate in grey matrix. Barren of fossils. (Fleurant conglomerate; type locality Fleurant point; also seen at Mushroom rock and southeast of Englishman creek ⅓ mile)	45
E. Grey, argillaceous shales and sandy shale interbedded with shaly and thin-bedded sandstone terminating in a 16-foot member (E1) of reddish beds. Fossil fish and fine plant fossils. (Escuminac beds, Maguasha bay)	370
Disconformity at top	
F. Red shales and conglomerates; angular limestone fragments furnishing most of pebbles, with boulder conglomerate member at base (F1). Barren of fossils. Bonaventure formation (Yacta point and Hugh Miller cliffs)	850

The basal beds (A) of this section are largely covered under ordinary conditions of the beach. But they are of special interest because they contain the only fossils known in the section below the fish beds which lie at an horizon nearly 1,000 feet above them. The beds with the coal seam lie below high-tide level and can only be seen after making a considerable excavation of the beach deposits. The beds which include the coal seam consist of grey-green shales, some of which are full of plant fragments, and red to chocolate shale interbedded with coarse-pebble conglomerate. They show a strike of 84 degrees and dips of 45 degrees to 90 degrees. Ostracods are abundant in an outcrop 105 paces east of the bridge near A. Mackenzie's house. About 20 feet nearer the bridge a seam of coal 2¼ inches thick occurs on the intertidal zone associated with numerous plant fragments. The coal and associated beds dip at about 45 degrees. A second small seam of coal is reported to be present a few feet from the one seen by the writer. Soft shales which alternate with thin beds of conglomerate are characteristic of this terrain. The exposed beds include about 200 feet of strata which are separated by a covered interval representing 200 feet or more, which separates the beds with thin coal seams and ostracods from the conglomerate formation that follows (Figure 3).

Coal Analysis

The writer had the old excavation reopened and collected samples of the coal, which were analysed by H. V. Ellsworth of the Geological Survey, Canada, who has supplied the following results.

"The specimens gave the following results by rapid analysis:

Ash	16·16
Fixed carbon	52·09
Volatile matter (hydrocarbons and total H_2O)........	31·75
	100·00
H_2O at 110°	4·89

It burns to a reddish ash that does not fuse."

This coal seam has been known to the owner of the land on which it occurs for many years, but it has apparently not previously come to the notice of any geologist.

Origin and Correlation of Sediments

All the characteristics of the 1,400 feet of sediments, beginning with the coal seam and terminating with more than 300 feet of grey sandstone and shale, stamp it as a continental deposit laid down in lagoons, freshwater lakes, or along wide river valleys. The late Devonian plants and fishes found in the upper 300 feet indicate either fluvial or lacustrine sediments. The presence of three considerable beds of conglomerate, B, C1, and D, display the work of powerful currents. In the case of D, the Fleurant conglomerate, the polished, well-rounded boulders, many more than one foot in diameter, have been attributed by Clarke to ice action. The absence of striæ, however, appears to indicate that river currents have been the agents by which they have been rounded and transported. In the small, angular-pebble conglomerate of C and Cl we seem to have pebbles that were transported by small streams for only short distances, which did not afford the long milling essential to produce rounded outlines, whereas the rounded boulders of the Fleurant conglomerate suggest a river journey of considerable length and gradient.

In seeking to correlate the beds at Escuminac bay containing the coal seam with their equivalent elsewhere, their resemblance to the Gaspe sandstone at Gaspe bay becomes apparent.

In the lower part of the Gaspe sandstone of Gaspe bay, Logan found a 3-inch coal seam—the only one in 7,000 feet of strata he states[1]—lying as the Pirate Cove coal does below reddish beds. These two occurrences of coal represent in the writer's opinion approximately the same horizon in the Gaspe sandstone series.

The lower 600 feet of Logan's Gaspe section include above, the coal seam beds with *Psilophiton,* on some of the leaflets of which *Spirorbis* is found. This occurrence of fossil plants and *Spirorbis* above the coal band at Little Gaspe is duplicated in the succession found by the

[1] Logan, Wm. E.: Geol. Surv., Canada, Rept. of Prog. 1863, pp. 404-405.

writer at Pirate cove in Escuminac bay where a coal seam 2¼ inches thick is followed by shales containing *Lepidodendron, Psilophiton,* and the small shell *Spirorbis.*

Other resemblances between the lower part of the Gaspe sandstone of the Gaspe section and the beds in Pirate cove are the tendencies of the beds in each section to alternate from drab to reddish sandstones, associated with red to chocolate shale and green shale in the Pirate Cove section and "Claret red and green" shale in the Gaspe section. The "Red sandstone"[1] and interpolated red argillaceous shales of Logan's Gaspe sandstone with conglomerate bands of quartz, jasper, and limestone, are rather closely matched by the coffee coloured to dull red shale and conglomerates of the Escuminac Bay section near the mouth of Englishman creek.

The Pirate Cove coal seam lies several hundred feet below a marked disconformity that marks the line between fossiliferous beds below and barren red conglomerates and shales above. This disconformity appears to be the logical place to draw the Bonaventure-Gaspe sandstone boundary, lying as it does at the base of the bright red sediments at the top of the fossiliferous rocks, and several hundred feet above a coal that seems to correlate with the coal located in the lower part of the Gaspe sandstone (Figure 3 and Plate I C).

At the top of the Gaspe sandstone of the type section Logan[2] reported 663 feet of "Drab, massive sandstone containing comminuted plant remains and interstratified with red beds only at the bottom. These appear to correlate with the Escuminac beds of the Escuminac Bay section (E of the preceding section). The drab sandstones of the Gaspe formation lie between the red Bonaventure conglomerate above and "red sandstone" below, just as the Escuminac beds and their basal conglomerate formation lie between red conglomerates above and dull red argillaceous shales and conglomerates below, which include the coal seam of Pirate cove.

TYPE SECTION

The Bonaventure formation was first described by Logan. He defined it as "a series of red sandstones, interstratified with beds of a coarse calcareous conglomerate. The island of Bonaventure, opposite to Percé, is entirely composed of this series; for which we have, in consequence, chosen the name of Bonaventure formation."

Apparently neither Logan, Ells, nor Clarke was aware that the bottom of the Bonaventure conglomerate was defined at the type locality on Bonaventure island by an older formation. Logan's impression that it was not so defined is reflected in his omission to cite any basal boundary of the formation on Bonaventure island. Clarke states[3] that "the rocks of the island are entirely of the Bonaventure conglomerate and represent the upper beds, the basal limestone not being present." At the northeast corner of the island the writer found the Bonaventure formation resting on a limestone base of Devonian age (Plate I A).

[1] Logan, W. E.: Geol. Surv., Canada, p. 528 (1863).
[2] Ibid, p. 396.
[3] Clarke, J. M.: Mem. 9, p. 95 (1908).

A fauna representing the Grande Greve limestone was collected hen which includes the following species.

Leptocoelia flabellites (Conrad)
Leptostrophia magnifica (Hall)
Chonetes canadensis Billings
Strophonella (Amphistrophia) cf. *continens* Clarke
Megalanteris thunei Clarke
Beachia cf. *amplexa* Clarke
Spirifer murchisoni Castelnau
Palaeopinna? sp.
Tentaculites cf. *carteri* Clarke
Dalmanites cf. *lowi* Clarke

The ledges that furnished this faunule clearly represent a seaward extension of the Grande Greve limestone so well exposed in Percé island and the cliffs beyond cape Barré to the northwest of Bonaventure island. The basal limestone conglomerate of the Bonaventure is not only present on the island, but is so largely composed of limestone pebbles that its reaction to subaerial erosion is similar to a limestone; wide fissures are dissolved out of this limestone conglomerate and shallow, cave-like depressions are formed as in a limestone area. It is only near the northeastern corner of the island that the base of the Bonaventure is exposed. Elsewhere it extends below sea-level. The maximum height of the vertical cliffs on the east side of the island where the Bonaventure conglomerate lies horizontally is approximately 400 feet. Dips of 5 degrees to 15 degrees about the west and south sides of the island appear to add 100 feet or more to the thickness shown by the maximum height, giving a total thickness for the formation of about 500 feet. The red shales and rather soft red sandstones that lie between successive beds of conglomerate are best exposed on the west and south sides of the island. The limestone conglomerates with their scattering quartz, jasper, and other non-calcareous pebbles are essentially grey, with very little red, except in cliffs where the red shale and sandstone above have supplied a superficial coating of red to the whole mass. No trace of plant or animal fossils has been found in the Bonaventure conglomerate on the island or at other localities where an unconformable limestone base leaves no question concerning the downward limits of the Bonaventure.

On the mainland 3 miles northwest of Bonaventure island the cliffs at the southwest corner of mount St. Anne and the adjacent conglomerate ledges west of the mountain road near that point furnish a section of the Bonaventure which is about 800 feet thick. This rests on Palæozoic limestones and shales (Plate I A).

AREAL DISTRIBUTION OF THE GASPE SANDSTONE AND THE BONAVENTURE, WEST OF THE TYPE SECTION

The bright red cliffs of the Bonaventure formation border much of the north shore of Chaleur bay for about 125 miles. They are composed chiefly of coarse conglomerate, sandstone, and shales. These are most strikingly displayed near the western and eastern ends of this long line of outcrops. Near the western end are the high Hugh Miller cliffs of red conglomerate which overlook Escuminac bay and overlie disconformably beds with Devonian fishes representing the top of the Gaspe sandstone. At the eastern end is the red cap of mount Ste. Anne with its precipitous cliffs which look down from an elevation of 1,200 feet on Bonaventure island, the type locality of the Bonaventure formation with its girdle of red conglomerate and sandstone cliffs. A considerable break in the coastal belt of Bonaventure sediments occurs between Chandler and Port Daniel. There is still another break at Black cape where high cliffs of the Silurian section replace the Bonaventure formation along the coast-line. But the presence of fissures in the Silurian rocks at Black cape, filled with Bonaventure conglomerate and other remnants in the Palæozoic near Port Daniel, attest the former extent of the Bonaventure over the whole of the coast-line zone from Escuminac river to Bonaventure island (Figure 3).

Over all of this long line of outcrop east of Nouvelle river the Bonaventure formation lies nearly horizontal, except where disturbed by faulting, upon the upturned edges of Palæozoic limestones, shales, and quartzites (Plate I B). But west of Nouvelle river this unconformable relationship of the Bonaventure to much older formations gives place to disconformable relations with a formation but slightly older than the Bonaventure. West of Nouvelle river the Bonaventure, instead of resting unconformably on rocks of a distinctly different type and a very much earlier date, follows sediments having some resemblance to the Bonaventure, but with fossil-bearing horizons and separated from it by a disconformity instead of an unconformity.[1] It is apparent from the Escuminac Bay section that a set of beds with a thickness of 1,400 feet or more, representing the upper part of the Gaspe sandstone, terminate rather abruptly between Nouvelle and Cascapedia rivers. No trace of these older continental sediments has been found in the 100-mile belt of the coast between Nouvelle river and mount Ste. Anne at Percé. North of mount Ste. Anne, 6 miles, the 7,000-foot section[2] of Gaspe sandstone measured by Logan appears with the same abruptness that the coal plant, and fish-bearing beds do at Escuminac bay.

The Bonaventure near both its eastern and western limits displays strangely enough a considerably greater thickness of sediments than it shows in any of its intermediate sections.

COMPARISON OF BONAVENTURE AND CATSKILL

The Bonaventure conglomerate has been compared to the Catskill of New York by Dr. J. M. Clarke in various discussions of this youngest Palæozoic formation in Gaspe peninsula. A broad review of the areal distribution of the Bonaventure and the Gaspe sandstone which is its chronologic predecessor in Gaspe peninsula, however, makes the contrasts between the Catskill and Bonaventure much more striking than their resemblances. Both the Catskill and the Bonaventure are continental deposits of about the same age. Each is the terminal Palæozoic formation

[1] *See* Geol. Surv., Canada, Bull. 44, sections opposite p. 36, for structural features of Port Daniel area.

[2] Ells, R. W.: Map, Geol. Surv., Canada, 1884. *See also* J. M. Clarke: "Geological Age of the Bonaventure Formation"; N.Y., State Mus. Bull. No. 251, pp. 123-130 (1924).

in its own region, and red sediments in which conglomerates are prominent dominate both. But we find between the two these contrasts: the Catskill continental sediments followed westward across New York interfinger with the Chemung marine sediments, whereas the Bonaventure followed westward for 100 miles from its region of typical development remains where it abruptly terminates at or near the Hugh Miller cliffs as completely a continental formation as it is at the type locality and with a thickness not greatly differing from sections in the type region. Moreover, the Bonaventure in its most westerly development has disconformable relations to a subjacent formation of continental type, whereas the Catskill is conformable with the beds below it with marine faunas.

SOME MINERAL OCCURRENCES OF ECONOMIC INTEREST IN NEW BRUNSWICK

By F. J. Alcock

CLAY AND LIMESTONE NEAR BROOKVILLE

At the request of Mr. Charles H. Gibbon of St. John, a visit was made to a deposit of clay near Brookville, about 4 miles north of St. John city. Mr. Gibbon owns 70 acres of land consisting of marshy clay meadow surrounded by limestone hills. The association of the clay and the limestone suggested a possibility of their use for the manufacture of cement. The property lies along both the main motor highway and the Canadian National railway line from St. John to Moncton.

The rocks of the region consist of limestone, diabase, and granite. The hills to the west and north of the meadow rise to elevations of about 200 feet and consist of limestone of Precambrian age, forming part of a limestone-dolomite belt that extends from Green head west of St. John to Torryburn, 1½ miles northeast of Brookville. The rocks strike north-northeast and at some six places quarries were opened for the preparation of lime. The limestone is bluish and is cut by narrow dyes of diabase, usually less than a foot in width. Along the borders of the dykes the limestone commonly shows a narrow white band, decoloured by the action of the intrusive. The following analyses[1] of samples taken from the quarries at Drury cove, a quarter of a mile to the west of Brookville, show the composition of the limestone.

Sample	Insoluble matter	Fe_2O_3+ Al_2O_3	$CaCO_3$	$MgCO_3$	CaO	MgO
Drury cove, No. 1..............	2·20	0·24	96·60	0·98	54·10	0·47
Drury cove, No. 2..............	2·00	0·24	97·68	0·27	54·70	0·13
Drury cove, No. 3..............	1·86	0·28	96·69	0·53	54·15	0·25

A sample collected by the writer and analysed in the laboratory of the Mines Branch, Department of Mines, Ottawa, gave the following results:

Insoluble matter	Fe_2O_3+ Al_2O_3	$CaCO_3$	$MgCO_3$	CaO	MgO
1·62....................................	0·14	95·85	1·52	53·68	0·73

[1]Hayes, A. O.: Geol. Surv., Canada, Sum. Rept. 1913, p. 241.

A quarter of a mile south of Brookville, granite is exposed in a railway cut. The contact with the limestone takes a direction a little east of north, the high hills to the east of Brookville consisting of granite.

The clay area lies to the west of the motor road and railroad. It is flat and marshy and is drained by the northwest branch of March creek. A divide of limestone about 200 yards wide separates it from Drury cove, a part of Kennebecasis bay. According to the topographic map of the region the surface of the marsh lies at an elevation of about 18 feet above mean high tide. There is thus not much opportunity to thoroughly drain the marsh, but the opening up of the creek's channel near the outlet of the marsh where there is a fall of several feet would be of some help in this respect.

The clay was examined at a number of places in the marsh and samples collected with an auger at depths of about 6 feet. An analysis made in the laboratory of the Mines Branch, Department of Mines, Ottawa, gave the following composition of typical material, dried at 104° centigrade.

	Per cent
SiO_2	67·10
Fe_2O_3	4·79
Al_2O_3	15·05
CaO	1·44
MgO	1·55
K_2O	2·55
Na_2O	1·50
Loss on ignition	5·62
Total	99·60

The clay appears to have been formed as a lake deposit. The writer was informed by Mr. Gibbon that boring operations have shown depths of clay of from 30 to 40 feet and that one boring went to a depth of 180 feet without encountering bedrock. Should clay ever be required in the vicinity, the property is worthy of investigation.

STARRS ISLAND COPPER DEPOSIT

An occurrence of chalcocite on Starrs island near St. John was staked about 1916 and a certain amount of work has been done on the property during recent years. The island lies about a mile northeast of Millidgeville, in Kennebecasis bay, about 500 feet off the southeast shore. It is about 1,000 feet in length; the mineral showing is on the northwest side near the shore.

The rocks of the island consist of altered limestone and intrusives. The former is highly contorted with irregular strikes and dips. Its age is Precambrian. In places it is altered to lime-silicate rock consisting of pink garnet and green epidote. These silicate masses are of various sizes and shapes and occur irregularly scattered through the limestone. At the south end of the island are dark masses of rock, some of which have sharp boundaries against the limestone. A thin section of a specimen from one such mass was seen to consist of labradorite and augite and hence is a gabbro. Another section shows a great deal of carbonate and epidote in addition to feldspar and probably represents an intrusive that has assimilated some limestone.

The chalcocite occurs as small masses and grains in the lime-silicate portions of the altered limestone. There appears to be no definite trend or regularity to the occurrences. The largest piece of chalcocite seen by the writer was about the size of a man's fist.

The association of the chalcocite with the secondary silicate minerals suggests a common origin for them all. They were evidently produced at high temperatures under conditions of contact metamorphism. The dykes that cut the limestone are not large enough to have produced this change, but they may be differentiates of a larger mass underlying the limestone. Granite masses cutting Precambrian limestone occur in the vicinity of St. John.

A small amount of surface work in the form of an open-cut has been carried out, but the amount of ore exposed is very small, and its scattered character does not offer much hope of a deposit of commercial importance being found.

GYPSUM NEAR APOHAQUI

A deposit of gypsum occurs on the farm of Michael Guilfoyle near Apohaqui, Kings county, New Brunswick, and smaller exposures along the same line of strike are known both to the east and to the west. The property is about 3½ miles west of Sussex on the main motor highway from St. John to Moncton and is within half a mile of the Canadian National Railway line connecting these two points. The distance to St. John, which would be the place of water shipment, is 40 miles.

The rocks exposed on the property belong to the Windsor series of Lower Carboniferous age. They consist of conglomerate, limestone, and gypsum beds. The conglomerate, which is the oldest, forms a prominent ridge running in a direction slightly north of east. The beds strike in the same direction and dip to the north at angles of from 35 to 55 degrees. Overlying the conglomerate is a limestone horizon which is exposed in two places. The limestone is dark grey and dips to the north at 55 degrees.

The gypsum beds outcrop to the north of the conglomerate and limestone. Outcrops are abundant over a width of 600 feet and where exposures can not actually be observed the hummocky nature of the belt and the numerous sink-holes indicate the character of the rock beneath. The gypsum is of the massive crystalline type. At one place where the bedding planes could be observed the dips are low. It was found impossible from the surface exposures to determine the thickness of the beds, but in some of the hummocks a vertical thickness of over 40 feet is exposed. No development in the form of drilling or open-cut work has been done to explore the tonnage available, but the surface indications suggest that it is large and that mining costs would be low.

ANNIDALE COPPER DEPOSIT

During the past summer development work was carried out by the Canadian International Corporation on a copper prospect near Annidale. A vertical shaft was sunk to a depth of 108 feet and crosscutting was carried out for a distance of 12 feet in a north direction and 16 feet in a south direction. Work closed down on September 7.

A description of this deposit is given by M. E. Wilson in the Summary Report of the Geological Survey, 1926, part C; under the name Dick copper prospect. The mineralization consists of chalcopyrite, pyrite, and quartz, along sheared zones in altered volcanic rocks. The new shaft is located on the north side of pit No. 3. This pit shows a sheared zone in volcanics, which has a width of 5 feet. It is bordered by slickensided surfaces, and is mineralized with pyrite, chalcopyrite, and quartz. In the zone is a mass of nearly solid chalcopyrite, 14 inches wide, with a second parallel mass about 4 inches wide. The mineralized zone dips steeply to the north. The shaft is located about 10 feet north of the pit. It was expected that the mineralized zone would be intersected by the shaft and picked up again in a crosscut. At the time of the writer's visit the shaft had a depth of only 38 feet and the ore zone had not been encountered.

DEEP BORINGS IN ONTARIO, QUEBEC, AND THE MARITIME PROVINCES

By D. C. Maddox

The Borings Division has charge of the work of collecting and organizing all information that it is possible to obtain with reference to drilling operations for oil, gas, water, non-metallic minerals, and coal, but not including diamond drilling for the purpose of testing the values of metalliferous deposits. The information desired is of two kinds: the nature and thickness of the various rocks passed through in the course of drilling; and the depth at which products of interest or of value (as oil, gas, water, etc.) are obtained, as also their quality and quantity. Information as exact as possible as to the position of the well and as to the elevation above sea-level of the top of the well forms an important part of the data desired. The information is available to all and much unproductive drilling might be prevented by its use and drillers would best serve their own interests by supplying the division with all pertinent information regarding drilling operations.

Samples of the rocks penetrated and written records are desired in the case of any drilling. The samples are taken by the driller and usually cover a depth of 5 or 10 feet. The division supplies bags for the samples which may be sent free of mailing charges to Ottawa where the material is examined and finally stored for future use. A written report giving the results of the examination of the samples, accompanied by a geological interpretation of such results, is forwarded to the sender. For water wells, standard questionnaires are forwarded to the driller for completion by him. In Ontario records and samples obtained from wells drilled for oil and gas are collected by Col. Harkness, the Gas Commissioner for that province. During 1928 only records of such wells drilled in Ontario were received by the division, the samples being held at Toronto. Col. Harkness has kindly consented to provide the division with all information available regarding the oil and gas wells as they are drilled. Co-operation has also been established with other institutions. The Department of Agriculture, the Canadian National railway, the Canadian Pacific railway, and many others have so co-operated and acknowledgments are due to them. The Quebec Department of Health has also provided much useful information with reference to water analysis and thanks are due to the engineers of the waterworks of many cities for information of a similar nature. The Oil Well Supply Company provided a very complete list of drillers in the province of Ontario. Lists of drillers were also received from Mr. McMullen of the Nova Scotia Department of Lands and Mines and from Mr. Shaw of the Department of Public Works, P.E.I. Many drillers have most loyally supported the work of the division and it is hoped that many more will be induced to assist. It is only by the co-operation of government departments, well drillers, and well owners that the Geological Survey can hope to collect the necessary data from so large an area as that involved. The very nature of the work renders much of the information practically useless unless recorded at the time the wells were being drilled.

Driller's Associations have been formed in several of the states of the United States of America and seem to have been a great success by providing a means for the interchange of knowledge and by creating a spirit of mutual help. Government geologists have played a prominent part in the proceedings of these associations chiefly in connexion with the discussion of drilling problems, water conservation, and the geology of water supply. No such associations on a large scale have yet been formed in Canada.

During the past year data of a general nature as to water conditions at depth were furnished by Mr. Robert Connell of Manitowaning, covering Manitoulin island; by Mr. Amos Clarke covering Dundalk district, Ont.; by Mr. Ed. Desroches covering Miscouche area, P.E.I.; and by Mr. Thos. Kennedy of Chatham, N.B., for information regarding the country bordering the lower part of Miramichi river, N.B. Mr. Azarias Rioux, well driller of Montreal, supplied much general information on water conditions in some of the smaller towns and villages of the province of Quebec.

The only samples received from wells put down in Ontario for oil or gas were from a well put down near Collingwood by Mr. Robert Cherry; thirty-one samples were received and examined. A point of special interest in connexion with these samples was the discovery of a bed of bentonite at a depth of 320 feet from about the middle of the Trenton group, as far as can be determined in the present stage of the drilling. A sample of the material was forwarded to Dr. C. S. Ross of the United States Geological Survey who has worked on Palæozoic bentonites and he reported that the bentonite closely resembles similar material from the Ordovician of Tennessee and Virginia. In the case of wells drilled for water in Ontario, 369 samples were received and examined.

In the province of Quebec no drilling for oil and gas seems to have been done. A well put down at the Dominion Experimental Farm at L'Assomption provided information of considerable interest. The well passed through igneous rock at two horizons, 285 feet to 385 feet and 580 feet to 630 feet. Apparently the igneous rock represents dykes and there seems to be evidence of duplication of the strata by faulting. The number of samples received from wells in the province of Quebec was 94.

In New Brunswick drilling for oil and gas was confined to that done by the New Brunswick Gas and Oilfields in the Stoney Creek field and near Gautreau on the east side of Petitcodiac river. Dr. Henderson who has charge of the work continued his cordial co-operation with the division, and 222 samples from the Gautreau well of this company were received. A sample of hydrocarbon suspected to be anthraxolite, taken from a boring on the Legassie farm near Fredericton, was examined.

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Drilling for oil and gas in the province of Nova Scotia was largely confined to the putting down of test holes for the purpose of determining structure. Mr. John Ness of the Imperial Oil Company kindly supplied information on six such test holes put down in Minudie district, Cumberland county. Thirty-three samples from water wells were received and examined. Two of the wells passed through the Meguma gold-bearing series and one through the Triassic igneous rock of the north shore.

The abandonment of the two deep wells drilled by the Daugherty Company on Governor island, Charlottetown, P.E.I., seemed to mark, for the present, the conclusion of drilling for oil and gas in the island province. All information received was from wells put down for water.

A certain amount of work not directly connected with borings was undertaken by the Borings Division in 1928. This work was done in an attempt to reply to an inquiry as to the hardness of water in the chief Canadian cities and towns. Sufficient information was obtained to satisfy the demands of the inquiry.

Ontario: Wells Drilled for Oil and Gas

Records Received, 1928

Lot	Concession	Township	County	Year drilled	Depth in feet covered by records	Yield	Depth in feet to first rock	Depth from surface to water Feet	Drilling company, well name, etc.
16	7	Jocelyn	Algoma	1927	680		148	Fresh 125, Sulphur 200, 590	H. Fremlin and W. Armstrong
15	3	Onondaga	Brant	1927	705	Gas	92		Onondaga Oils and Gas Co.
21	3	"	"	1927	652	"	60	Fresh 81	" "
8	3	Tuscarora	"	1927	840	"	10	Fresh 40	Heart of Reserve Syndicate
13	6	"	"	1927	668	"	56	Sulphur 57	Petrol Oil and Gas Co.
NE. 8	3	"	"	1927	801		10	Fresh 38	Senator Michener
7	1 F.R.	Gosfield S.	Essex	1927		Gas			Bon Jasperon
8	1 "	"	"	1927		"			"
8	1 "	"	"	1927		"			"
8	1 "	"	"	1927		"			"
		Canborough	Haldimand	1927	530	"	82		Lincoln Gas Syndicate
		"	"	1927	570	"	83		" "
		"	"	1928	568	"	80		" "
6	4	Cayuga S.	"	1927	722		63		W. C. Patterson
26	4	"	"	1927	848	Gas	24	Sulphur 65	South Cayuga Oil and Gas Co.
27	4	"	"	1927	845	"	17		" "
24	4	"	"	1927	845	"	25	Sulphur 70	" "
25	4	"	"	1927	845	"	24	Sulphur 68	" "
24	3	"	"	1927	820		40		" "
22	1	Cayuga N.	"	1927	707	Gas	70		W. C. Patterson
23	1	"	"	1927	698	"	43		"
23	1	"	"	1927	700	"	43		"
SW. ½ 20	1	"	"	1927	633	"	58		"
22	1	"	"	1927	663		60		"
22	1	"	"	1927	744	Gas	62		"
23	1	"	"	1927	758	"	58		"
23	1	"	"	1927	728	"	41		"
22	1	"	"	1927	735	"	49		"
23	1	"	"	1927	730	"	40		"
22	1	"	"	1927	704		54		"
20	1	"	"	1927	723	Gas	57		"

Ontario: Wells Drilled for Oil and Gas—Continued

Records Received, 1928—*Continued*

Lot	Con-cession	Township	County	Year drilled	Depth in feet covered by records	Yield	Depth in feet to first rock	Depth from surface to water Feet	Drilling company, well name, etc.
24	1 S.T.R.	Cayuga N....	Haldimand...	1927	702	Gas....	40	Fresh 120, Black 350	Dom. Natural Gas Co.
24	1 "	"	" ..	1927	698	"	36	....	" "
21	1 "	"	" ..	1927	711	"	....	....	" "
13	3	"	" ..	1927	735	....	65	Fresh 70, Black 360.	" "
19	2	"	" ..	1927	724	....	62	Fresh 65, Black 350.	" "
21	1 S.T.R.	"	" ..	1927	706	Gas....	47	Fresh 65, Black 350.	" "
26	1 "	"	" ..	1927	708	"	38	Fresh 85, Black 350.	" "
27	1 "	"	" ..	1927	718	....	49	Fresh 75, 100, Black 350.....	" "
13 and 14	14 N.T.R.	"	" ..	1927	790	Gas....	68	....	W. C. Patterson
21	1 S.T.R.	"	" ..	1927	707	....	51	....	Dom. Natural Gas Co.
27	1 "	"	" ..	1927	693	....	50	Fresh 75, Black 350.	" "
36	2–3	Dunn........	" ..	1927	876	Gas....	85	....	W. C. Patterson
36	2–3	"	" ..	1927	878	"	86	....	"
5	2	"	" ..	1927	815	"	78	....	"
4	2	"	" ..	1927	780	"	68	....	"
3	2	"	" ..	1927	860	"	63	....	"
S. ½ 3	2	"	" ..	1927	807	"	64	....	"
3	1	"	" ..	1927	789	....	64	....	"
3	1	"	" ..	1927	831	Gas....	63	....	"
1	3	"	" ..	1927	790	"	65	....	"
6	2	"	" ..	1927	719	....	73	....	"
2	4	Rainham.....	" ..	1927	960	Gas....	13	Fresh 23, 41, Black 482...	Dom. Natural Gas. Co.
7	4	"	" ..	1928	909	"	16	Fresh 59, Black 468.	" "
1	6	"	" ..	1927	897	"	17	Fresh 41, Black 468.	" "
6	4	"	" ..	1927	916	"	15	Fresh 30...........	" "
9	4	"	" ..	1927	906	"	51	Fresh 57, Black 466.	" "
6	1	"	" ..	1927	892	"	11	Fresh 60, Black 510.	" "
17	1	"	" ..	1927	895	"	4	Fresh 26, Black 510.	" "
9	4	"	" ..	1927	914	"	28	Fresh 25, Black 45..	" "
8	3	"	" ..	1927	912	"	26	Fresh 48, 55, Black 470.......	" "

7	3	"	"	1927	969	"	24	Fresh 57, Black 457.	" "
7	4	"	"	1927	905	"	22	Fresh 61, Black 478.	" "
9	3	"	"	1927	903	"	42	Black 598...........	" "
21	1	"	"	1927	840	....	2	Fresh 16, Black 475, Sulphur 37	" "
S. ½ 2	6	"	"	1927	917	Gas....	12	Sulphur 60..........	Erie Gas and Oil Syndicat,
3	6	"	"	1927	930	"	12	Sulphur 60..........	" "
3	6	"	"	1927	910	"	12	Sulphur 60..........	" "
10	4	"	"	1927	900	"	17	....	Haldimand Gas Fields Syndicate
9	6	"	"	1927	860	"	2	Sulphur 30..........	" "
12	5	"	"	1927	878	"	4	Sulphur 35..........	" "
10	6	"	"	1927	865	"	17	Sulphur 30..........	" "
10	5	"	"	1927	900	"	24	Sulphur 60..........	" "
10	5	"	"	1927	900	"	15	Sulphur 35..........	" "
2	5	"	"	1927	870	"	16	....	" "
9	4	"	"	1927	880	....	15	....	" "
10	5	"	"	1927	900	Gas....	28	Sulphur 40..........	" "
2	5	"	"	1927	890	"	15	....	" "
S. ½ 11	5	"	"	1927	866	"	28	Sulphur 35..........	" "
23	1	Seneca.......	"	1927	702	"	62	....	Port-Colborne-Welland Gas and Oil Co.
21	1	"	"	1927	700	"	54	....	" " "
21	1	"	"	1928	706	"	63	....	" " "
24	1	"	"	1927	685	....	60	....	" " "
22	2	"	"	1927	687	Gas....	86	....	" " "
23	1	"	"	1927	711	"	55	....	" " "
8	5	Walpole.......	"	1927	963	....	23	Fresh 62, Black 500.	Dom. Natural Gas Co.
15	5	"	"	1927	953	....	23	Fresh 75, Black 465.	" "
16	5	"	"	1927	913	Gas....	18	Fresh 80, Black 474.	" "
19	10	"	"	1927	931	"	18	Fresh 65, Black 440.	" "
15	5	"	"	1927	947	"	23	Fresh 85, Black 492.	" "
23	6	"	"	1927	902	....	4	Fresh 20, Black 470.	" "
14	5	"	"	1927	952	Gas....	20	Fresh 95, Black 510	" "
3	2	"	"	1927	1,011	"	25	Fresh 102, Black 532	" "
2	2	"	"	1927	1,031	"	36	Fresh 90, Black 547.	" "
9	9	"	"	1927	886	"	22	Fresh 35, Black 432.	" "
4	3	"	"	1927	1,015	....	26	Fresh 100, Black 526	" "
23	8	"	"	1927	887	Gas....	14	Fresh 40, Black 468.	" "
14	5	"	"	1927	956	"	9	Fresh 50, Black 505.	" "
7	6	"	"	1927	950	....	25	Fresh 60..........	" "
22	9	"	"	1927	877	Gas....	40	Fresh 50, Black 453.	" "
17	10	"	"	1927	876	....	14	Fresh 40..........	" "
15	6	"	"	1927	955	Gas....	12	....	" "
19	9	"	"	1927	880	....	8	Fresh 17, Black 430.	" "
17	9	"	"	1927	880	Gas....	13	Fresh 28, Black 440.	" "
23	4	"	"	1927	898	"	13	Fresh 40, Black 476.	" "
6	13	Camden......	Kent.........	1927	405	....	12	....	Ajax Oil and Gas Co.

Ontario: Wells Drilled for Oil and Gas—Continued

Records Received, 1928—*Continued*

Lot	Con-cession	Township	County	Year drilled	Depth in feet covered by records	Yield	Depth in feet to first rock	Depth from surface to water Feet	Drilling company, well name, etc.
6	13	Camden......	Kent.........	1927	425	....	45	....	Ajax Oil and Gas Co.
5	13	"	"	1927	361	Oil.....	34	....	Vacuum Oil and Gas Co.
5	13	"	"	1927	391	"	34	....	" "
5	13	"	"	1927	343	"	35	Fresh 306...........	" "
5	13	"	"	1927	388	Gas....	63	....	" "
182	T.R......	Romney......	"	1927	1,355	"	220	Fresh 172, Salt 610, 670............	Union Natural Gas Co.
185	"	"	"	1927	1,340	"	163	Fresh 158, 170, Salt 585............	" "
184	"	"	"	1927	1,318	"	184	Salt 705, 1318.......	" "
183	"	"	"	1927	1,305	"	179	Fresh 172...........	" "
188	"	"	"	1927	1,362	"	172	Fresh 170, Salt 620..	" "
179	"	"	"	1927	1,360	"	169	Fresh 169, Salt 660, 1357............	" "
183	"	"	"	1927	1,771	"	165	Fresh 160, Salt 600..	" "
185	"	"	"	1927	1,286	"	157	....	" "
184	"	"	"	1927	1,284	"	165	Fresh 160, Salt 595..	" "
186	"	"	"	1927	1,307	"	165	Fresh 165, Salt 225, 590............	" "
186	"	"	"	1927	1,287	"	166	Fresh 164, Salt 579, 1,285..........	" "
186	"	"	"	1927	1,333	"	155	Fresh 155, Salt, 610, 730, Black 475...	" "
183	"	"	"	1927	1,232	"	170	Salt 680............	" "
184	"	"	"	1927	1,324	"	180	Fresh 173, Salt 590, 1,324..........	" "
183	"	"	"	1927	1,316	"	175	Fresh 170, 197, Salt 615, 1,311........	" "
180	"	"	"	1927	1,330	"	168	Salt 615............	" "
Gore A	2	"	"	1927	1,357	"	142	Fresh 142, Salt 400, Black 700.......	Southern Ontario Gas Co.
185	1	"	"	1927	1,302	"	167	Fresh 186, Salt 210, 600............	" "

27	1	"	"	1927	1,393	"	180	Black 310, 540, 600..	" "
194	1	"	"	1927	1,381	"	175	Fresh 175, Salt 1,381, Black 510, 698...	" "
187	N.T.R....	"	"	1927	1,341	"	151	Fresh 375, Black 675	" "
185	1	"	"	1927	1,305	"	187	Fresh 8, 180, Black 595............	" "
187	1	"	"	1927	1,302	"	165	Fresh 182, Salt 595, Black 207.........	" "
171	T.R......	Tilbury E....	"	1927	1,383	"	166	Fresh 165, Salt 690...	" "
24	9	Dawn.........	Lambton.....	1927	2,175	....	146	Fresh 53, Salt 420, 575, 1,270, 1,975..	Union Natural Gas Co.
24	8	"	"	1927	1,610	Gas....	175	Fresh 60, Salt 1,010, Black 540.........	" "
24	7	Dawn.........	Lambton.....	1927	1,642	Gas....	255	Fresh 60, Salt 630, Black 530.........	" "
24	9	"	"	1927	1,625	"	185	Fresh 55............	" "
24	9	"	"	1927	2,180	"	105	Fresh 52, Salt 575, Black 555.........	" "
23	5	"	"	1927	2,217	"	217	....	" "
24	10	"	"	1927	2,207	....	185	....	" "
W.½ 18	21	Enniskillen...	"	1927	520	....	130	....	C. E. Judson and Co.
5	7	Moore.........	"	1927	562	....	176	....	J. C. Appleman
22	9	Plympton.....	"	1927	454	Gas....	149	....	E. B. Blain
18	4	"	"	1927	525	"	160	....	S. Lucas
18	7 N.E.R.	Warwick......	"	1927	501	"	67	Black 488...........	H. B. Smith
W.½ 7	4	"	"	1927	703	Oil.....	110	Black 500...........	J. A. Welch Co.
15	2	Metcalfe......	Middlesex....	....	3,740	....	174	Fresh 210, Black 290	R. L. Barr and E. W. Fauling
25	9	"	"	1927	375	....	90	....	M. Crewson
29	4	Middleton....	Norfolk.......	1927	1,343	....	247	Fresh 287...........	Dom. Natural Gas Co.
30	3	"	"	1927	1,260	....	224	Sulphur 230.........	" "
30	3	"	"	1927	1,279	Gas....	259	....	" "
19	14	Walsingham N..........	"	1927	1,277	"	1,277	Fresh 255, Sulphur 912	" "
20	14	" ..	"	1927	1,251	"	215	Fresh 264...........	" "
20	14	" ..	"	1927	1,268	"	224	Fresh 260, Sulphur 910............	" "
23	13	Windham.....	"	1927	1,174	"	185	....	" "
22	6	Woodhouse...	"	1927	1,006	....	47	Sulphur 80..........	" "
21	17	Blanchard....	Perth.........	1927	3,174	Gas....	18	Fresh 75, 300, Salt 1,000, Sulphur 500.	St. Mary's Cement Co.
1	6	Crowland.....	Welland......	1927	715	"	84	....	Industrial Natural Gas Co.
2	6	"	"	1927	726	"	76	....	" "
20–21	Brantford Highway	Ancaster......	Wentworth...	1927	2,827	"	98	....	Premier Development Co.

Ontario: Shallow Water Wells

Records and Samples Received, 1928

Lot	Concession	Township	County	At or near	Year drilled	Depth in feet covered by records	Number of samples received	Remarks
	6	Culross	Bruce	Teeswater		173	3	Thompson Bros., by F. L. Davidson
	10	Huron	"			153	2	K. Finlayson, by F. L. Davidson
		Saugeen	"		1925			Southampton town, by M. S. Bellerby
		Nepean	Carleton	Ottawa	1928	361	4	National Defence Dept.
		Mulmur	Dufferin					D. W. Adair, by D. W. Adair
12	5	Mountain	Dundas	Mountain	1928	40	1	R. Bellinger, by I. Simzer
	7	Williamsburgh	"			65	4	R. McIntosh, by L. C. Barkley
	10	S. Dorchester	Elgin	Springfield		220	3	A. Leach, by A. McBeth
	8	Artemesia	Grey	Eugenia	1928	66	9	R. McMaster, by R. McMaster
9	2	Collingwood	"	Collingwood	1928	175	24	School Section No. 4, by R. McMaster
		Holland	"	Berkeley		160	3	R. Bradley, by R. McMaster
	A	Keppel	"		1928			G. Hewitson, by M. S. Bellerby
13	7	Osprey	"	Maxwell	1928	55	6	G. Ross, by R. McMaster
10	7	"	"	"	1928	49	8	R. Schomberger, by R. McMaster
40	11	Proton	"	Dundalk				A. Clarke, by G. Beamish
8		St. Vincent	"					F. E. Almond, by T. A. Gilroy
51	8	N. Cayuga	Haldimand	Nelles Corners	1928	60	6	Sun Oil Co., by J. T. Sitter
49	1	Rainham	"	Cayuga P.O.	1928	80	6	J. Armstrong, by J. T. Sitter
22	8	Walpole	"		1928	880		Dom. Gas Co., by J. J. McLister
18	9	"	"		1928	887		" "
22	7	"	"		1928	871		" "
22	8	"	"		1928	873		" "
27	3	Esquesing	Halton		1919	90		John Mann, by M. Crewson
32	1	"	"		1909	87		J. McMillan, by M. Crewson
6 and 7 W.	5	Nassagaweya	"		1902	48		D. Currie, by M. Crewson
28	6	"	"		1906	69		J. Lime, by M. Crewson
13	1	Tyendinaga	Hastings	Shannonvale	1928	50		A. Little, by Wm. Elliott
		Colborne	Huron	Galford	1920	215		Bisset Bros., by W. D. Hopper
		Grey	"	Watton	1921	125		Watton School, by W. D. Hopper
	13	Hullett	"	Harloch	1922	132		Harloch School, by W. D. Hopper
		"	"	Constance		125		J. Riley, by W. D. Hopper

	4	McKillop	"		Seaforth	1919		155		W. Kerr, by W. D. Hopper
	....	"	"		"	1924		197	....	G. McKee, by W. D. Hopper
	....	"	"		"	1924		246	....	Seaforth Public Utilities, by W. D. Hopper
11	8	Morris	"		Blyth	1928		108	....	J. Brewer, by W. D. Hopper
3	8	"	"		"	....		143	3	A. Pierce, by F. L. Davidson
....		"	"		Brussels	1921		54	....	F. Strutton, by W. D. Hopper
8	4	"	"		Belgrave	1928		106	1	W. Stubbs, by F. L. Davidson
	....	Stanley	"		Varna	1924		225	....	Dr. L. Moffatt, by W. D. Hopper
	....	"	"		....	1925		159	....	Stratford Rotary Club, by W. D. Hopper
	....	"	"		Zurich	1927		280	....	Zurich Public Utilities, by W. D. Hopper
32	10	Wawanosh E.	"		Wingham	1928		155	2	McGregor Sheill, by F. L. Davidson
42	9	"	"		Belgrave	1928		99	1	H. McClenaghan, by F. L. Davidson
40	5	"	"		Blyth	1928		202	2	S. Hallaham, by F. L. Davidson
	....	Camden	Kent		....	....		425	....	Mr. Percy, by W. J. Hussey
	....	"	"		....	....		388	....	W. Smith, by W. J. Hussey
	....	Raleigh	"		Cedar Springs	....		170	5	Mr. McPherson, by J. Bonner
28	3	Bosanquet	Lambton		Thedford	1928		72	8	Jos. Carrothers and Son, by A. A. Heal
27	5	"	"		"	1928		51	4	A. Elliott, by A. A. Heal
37	Lake Rd. E.	"	"		"	1928		23½	....	Lambton Celery Co., No. 1, by A. A. Heal
24	5	"	"		"	1928		73	12	C. Lockrey No. 1, by A. A. Heal
24	5	"	"		"	1928		33	....	C. Lockrey No. 2, by A. A. Heal
37	Lake Rd. E.	"	"		"	1928		30	4	W. J. Paisley No. 1, by A. A. Heal
38	"	"	"		"	1928		25	2	W. J. Paisley No. 2, by A. A. Heal
Sub-lot 1	C	"	"		"	1928		68	7	W. J. Paisley No. 3, by A. A. Heal
37	Lake Rd. E.	"	"		"	1928		23½	....	W. J. Paisley No. 4, by A. A. Heal
	....	"	"		"	1928		40	4	G. S. Paltridge, by A. A. Heal
35	Lake Rd. E.	"	"		"	1928		15	3	Thedford Celery and Fruit Co., by A. A. Heal
36	"	"	"		"	1928		16	....	Thedford Celery and Fruit Co., No. 2, by A. A. Heal
36	"	"	"		"	1928		25	....	Thedford Celery and Fruit Co., No. 3, by A. A. Heal
	....	"	"		"	1928		94	6	Thedford School, by A. A. Heal
27	6	"	"		"	1928		12½	2	School Section No. 3, by A. A. Heal
17	7	"	"		"	1928		64	6	W. O. West, by A. A. Heal
9	2	Enniskillen	"		Oil Spring	....		108	4	A. B. Johnston, by J. B. Johnston
15	2	"	"		" "	1927		71	....	Dr. Martin, by J. B. Johnston
9	....	"	"		" "	....		108	....	E. Mayler, by J. B. Johnston
17	13	Plympton	"		Thedford	1928		113	7	Wm. Cairans, by A. A. Heal
	....	Watford	"		Watford	1921		110	....	Watford Public Utilities, by O. M. Solymann

Ontario: Shallow Water Wells—Continued

Records and Samples Received, 1928—*Continued*

Lot	Con- cession	Township	County	At or near	Year drilled	Depth in feet covered by records	Number of samples received	Remarks
W. ½	10	Beckwith	Lanark	Carleton Place	1928	44	4	W. R. Caldwell, by A. Arbuckle
	10	"	"	" "	1928	40	4	P. McDonald, by A. Arbuckle
	11	"	"	" "	1928	60	5	N. Simpson, by. A. Arbuckle
9	9	"	"	" "	1928	78	8	Mrs. E. Shaill, by A. Arbuckle
4	12	Lanark	"	" "	1928	120	7	W. J. Munro, by A. Arbuckle
12	7	Ramsay	"	Almonte	1928	47	5	Wm. Cannon, by A. Arbuckle
1	6	"	"	Carleton Place	1928	57	....	J. Laroque, by A. Arbuckle
8	1	"	"	Almonte	1926	275	1	G. McCall, by A. Arbuckle
2	6	"	"	Carleton Place	1928	59	6	Rintoul Bros., by A. Arbuckle
16	8	"	"	Almonte	1928	110	11	J. Scoular, by A. Arbuckle
W. ½ 10	5	Richmond	Lennox	Selby	1928	70	7	C. Russel, by G. Chalk
	....	"	"	"	1928	35	4	C. Russel No. 2, by G. Chalk
S. ½ 23	5	"	"	"	1928	40	9	E. Robinson, by G. Chalk
	....	Clinton	Lincoln	Vineland	1928	42	....	Mr. Leslehevitch, by W. A. Lounsbury
	....	Grantham	"	St. Catharines	1927	100	....	S. Winery, by W. A. Lounsbury
	....	"	"	"	....	101	....	E. R. Cudney, by W. A. Lounsbury
	....	"	"	"	....	170	....	W. Winters, by W. A. Lounsbury
	....	Caradoc	Middlesex	Strathroy	1928	31	8	Strathroy Public Utilities Commission, by H. M. Anderson
	....	London	"	London	1927	134	....	F. D. Smith, by F. D. Smith
45	N.B.	McGillivray	"	....	1928	150	16	C. H. Curts, by Jas. Flynn
45	....	"	"	....	1928	90	9	C. H. Curts No. 2, by Jas. Flynn
31	1	Westminster	"	....	....	120	12	G. V. Reid, by A. B. Johnston
N. ½ 1	10	Blandford	Oxford	Bright	1924	182	....	Bright Cheese and Butter Manufacturing Co., by S. Rennick
S. ½ 17	7	Blenheim	"	Drumbo	1924	262	....	Mrs. N. E. Clark, by S. Rennick
S. ½ 21	9	"	"	....	....	220	1	A. L. Lewis, by S. Rennick
N. ½ 21	11	"	"	Bright	1924	149	....	Hewitt Bros., by S. Rennick
S. ½ 13	10	"	"	"	1924	178	....	E. Hunter, by S. Rennick
	....	Nissouri E.	"	Thamesford	1926	212	....	Geo. Hogg, by S. Rennick
1	11	"	"	"	1925	20	....	J. C. Patience, by S. Rennick

	....	Oxford N........	Oxford..............	Beachville..........	1920	171	....	M. J. Clayton, by S. Rennick
21	....	"	"	"	1925	40 8 ins.	....	Wm. Cook, by S. Rennick
	....	"	"	"	1926	51	....	H. Edwards, by S. Rennick
7	Broken Front	Oxford W........	"	"	1927	53	....	C. R. McCombs, by S. Rennick
3	1	"	"	....	....	327	3	J. W. Innes, by S. Rennick
15 E. H.	9	Zorra E........	"	Embro..............	1927	147	....	Mackay Bros., by S. Rennick
23	11	"	"	Tavistock..........	1927	106	....	G. R. Stewart, by S. Rennick
	....	Downie........	Perth..............	Sebringville........	1928	120	....	W. Ische, by W. D. Hopper
	....	"	"	"	1928	122	....	R. Kinich, by W. D. Hopper
30	6	Elma..........	"	Britton P.O..........	1915	158	....	T. R. Alexander, by Alexander Bros.
23	1	Sophiasburg....	Prince Edward......	Picton..............	1928	80	....	C. Hambly, by G. Chalk
23	1	"	" "	"	1928	50	....	E. Hambly, by G. Chalk
	1	"	" "	"	1928	60	....	School Section No. 10, by G. Chalk
36	1	"	" "	"	1928	156	....	A. Shortt, by G. Chalk
8	5	Westmeath.....	Renfrew..........	Beachburg..........	....	70	7	School Section No. 9, Westmeath, by A. W. Watson
	....	Essa..........	Simcoe..........	Thornton..........	....	192	....	D. W. Adair, by D. W. Adair
13	1	"	"	Alliston..........	1927	53	....	O. Bellerby, by O. Bellerby
7	7	Nottawasaga...	"	Dunedin..........	1928	151½	21	S. Jamieson, by R. McMaster
8	8	" ...	"	"	1928	125	9	S. Young, by R. McMaster
	....	" ...	"	East Collingwood...	1928	312	32	R. Cherry, by R. Cherry
S. ½ 16	Bleams Rd.	Wilmot..........	Waterloo..........	New Hamburg......	....	163	....	O. Cressman, by S. Rennick
25	1	Wainfleet.......	Welland..........	....	1920	86	....	B. F. Canby, by B. F. Canby
1	1	Erin..........	Wellington..........	Crewsons Corners...	....	35	....	M. Crewson, by M. Crewson
E. ½ 9	7	Eramosa.......	"	Rockwood..........	1916	135	....	E. Maud, by M. Crewson
7	4	Puslinch.......	"	Hespeler..........	....	2,205	....	Bollert Syndicate, by F. L. Snively
	....	Glanford.......	Wentworth..........	Hannon..........	....	87	....	S. Ecker, by W. Lofts
12	11	King..........	York..........	Lloydtown..........	1928	117	6	J. and M. Cairns, by W. C. Proctor
	....	York..........	"	Toronto..........	1925	920	....	Arena Gardens, Ltd., by Wm. Hoffman
	....	....	....	....	1928	135	12	G. Beamish, by G. Beamish

Quebec: Shallow Water Wells

Records and Samples Received

Township	County	At or near	Year drilled	Depth in feet covered by records	Number of samples received	Remarks
Grantham	Drummond	Drummondville		75	14	Canadian Celanese, Ltd., No. 1, by Can. Celanese.
"	"	"		114	23	Canadian Celanese, Ltd., No. 2, by Can. Celanese
Hull	Hull	Aylmer				Mr. Blackburn, by H. Friend
"	"	"				A. Soper, by H. Friend
St. Sulpice	L'Assomption	L'Assomption	1928		57	Experimental Farm, by Mr. Rioux

New Brunswick: Wells for All Purposes

Township	County	At or near	Year drilled	Depth in feet covered by records	Number of samples received	Remarks
Aberdeen	Carleton	Juniper	1928	61	2	Canadian Nat. railways, by J. Labrecque
Brighton	"	Hartland	1928	80		Dr. McIntosh, by P. Gorey
Wicklow	"	Centreville	1928	44½		C. Padget, by J. H. Simonsen
Wilmot	"	Lakeville	1928	80		J. Carter, by J. H. Simonsen
"	"	"	1928	56		H. Hamilton, by J. H. Simonsen
Glenelg	Northumberland	Chatham	1928	150		Can. International Paper Co., No. 1, by T. R. Kent
"	"	"	1928	412		Can. International Paper Co., No. 2, by T. R. Kent
"	"	"	1928	300		Can. International Paper Co., No. 3, by T. R. Kent
"	"	"	1928	300		Can. International Paper Co., No. 4, by T. R. Kent
"	"	"	1928			Can. International Paper Co., No. 5, by T. R. Kent
"	"	"	1928	191	2	Miramichi Lumber Co., by T. R. Kent
Brunswick	Queens	Alward	1928	168		Can. National railways, by J. Labrecque

Chipman	"	Bronson	1928	147	2	Can. National railways, by J. Labrecque
Dalhousie	Restigouche	Dalhousie	1914	45	....	A. Tait, by L. Arseneault
Eldon	"	Upsalquitch	1928	34	....	Can. National railways, by J. Labrecque
"	"	Falls Brook	1928	170	....	Can. National railways, by J. Labrecque
	"	Heron Island	1914	32	....	J. Creight, by L. Arseneault
	"	St. Quentin	1928	25	2	A. Saucier, by A. Saucier
Gladstone	Sunbury	Tracy Station	1912	110	....	E. A. Tracy, by Mr. Ball
Dorchester	Westmorland	Gautreau	1928	1,372	222	New Brunswick Gas and Oilfields, Ltd., No. 85.

Nova Scotia: Wells for All Purposes

—	Cumberland	Athol	1927	475	48	National Mines Well No. 1, by C. H. Watt
—	"	"	1928	300	30	National Mines Well No. 2, by C. H. Watt
—	"	East Leicester	....	250	3	R. R. McElmon, by O. V. Kennedy
—	"	Nappan	....	673	....	Nappan No. 1 well, by Imperial Oil Co.
—	"	"	....	159	....	Nappan No. 2 well, by Imperial Oil Co.
—	"	"	....	210	....	Nappan No. 3 well, by Imperial Oil Co.
—	"	"	....	104	....	Nappan No. 4 well, by Imperial Oil Co.
—	"	"	....	796	....	Nappan No. 5 well, by Imperial Oil Co.
—	"	"	....	298	....	Nappan No. 6 well, by Imperial Oil Co.
—	Digby	Bayview	....	300	3	O. V. Kennedy
—	Halifax	Cow Bay	....	70	4	E. C. Skinner
—	"	Halifax	....	410	8	Moirs Limited, by E. Trask
—	"	Waverley P.O	....	191	18	George Young, by E. C. Skinner

Prince Edward Island: Shallow Water Wells

Charlotte	Queens	Charlottetown	....	100	....	Charlottetown city, by J. Trainor
"	"	"	....	28	....	Charlottetown Waterworks, by J. Trainor
"	"	"	....	....	....	Charlottetown Waterworks, by J. Trainor
"	"	"	....	131	....	J. T. Ferguson, by J. Trainor
"	"	"	....	104	....	M. McKinnon, by J. Trainor
"	"	"	....	27	....	Wm. Stewart, by J. Trainor
"	"	Wheatley River	1927	110	....	J. T. Reeve, by J. T. Reeve
Hillsborough	"	New Wiltshire	1928	120	12	E. C. Proud, by J. Trainor
"	"	Bonshaw	1928	174	....	J. Tool, by J. Trainor

OTHER FIELD WORK

Geological

T. L. Tanton. Mr. Tanton commenced a geological survey of Shebandowan Lake map-area, western Ontario. This area lies between latitudes 48° 30′ and 48° 45′ and longitudes 90° 00′ and 90° 30′.

Robert Thomson. Mr. Thomson, under the direction of W. H. Collins, completed a study of the relations of the basic and acid edges of the Sudbury nickel eruptive, Ont.

W. A. Jones. Mr. Jones, under the direction of W. H. Collins, studied inclusions of sedimentary materials in gabbro near Sudbury and in granite near Killarney, Ont.

T. T. Quirke. Mr. Quirke commenced a geological survey of an area just east of Parry Sound, Ont., included by latitudes 45° 15′ and 45° 30′ and longitudes 79° 30′ and 80° 00′.

H. C. Cooke. Mr. Cooke briefly studied gold deposits in central Ontario, in the Kirkland Lake and Porcupine fields of northern Ontario, and in the Nova Scotia gold-bearing area.

A. E. Wilson. Miss Wilson continued the geological survey of the Cornwall map-area, eastern Ontario.

H. V. Ellsworth. Mr. Ellsworth spent several weeks in central and eastern Ontario studying rare mineral occurrences.

L. Gilchrist and J. B. Mawdsley. Professor Gilchrist of the Department of Physics, University of Toronto, and Mr. Mawdsley carried out investigations of electrical and electro-magnetic methods of prospecting.

T. H. Clark. Mr. Clark continued the geological survey of Sutton map-area, southern Quebec. This area is bounded by latitudes 45° 00′ and 45° 15′ and longitudes 72° 30′ and 73° 00′.

H. W. McGerrigle. Mr. McGerrigle, under the direction of T. H. Clark, commenced a geological survey of Lacolle map-area, southern Quebec, lying between latitudes 45° 00′ and 45° 15′ and longitudes 73° 00′ and 73° 30′.

Eugene Poitevin. Mr. Poitevin spent three weeks in the Eastern Townships of Quebec in a further study of the mineralogy of the serpentine belt.

S. A. Northrop. Mr. Northrop, under the direction of F. J. Alcock, commenced a geological survey of an area bordering Chaleur bay between Port Daniel and Black cape, Que.

E. M. Kindle. Mr. E. M. Kindle engaged in the study of various geological problems, in Gaspe peninsula.

Cecil Kindle. Mr. C. Kindle, under the direction of E. M. Kindle, commenced the geological survey of an area bordering Chaleur bay between Port Daniel and Mal bay, Que.

F. J. Alcock. Mr. Alcock commenced a geological survey of an area fronting on Chaleur bay between Belledune river and Nash creek, N.B.

E. R. Faribault. Mr. Faribault re-examined gold mines and prospects being operated in Nova Scotia. He nearly completed the geological survey of Digby map-area, N.S., bounded by latitudes 44° 30′ and 45° 00′ and longitudes 65° 30′ and 66° 00′.

I. W. Jones. Mr. Jones geologically surveyed the west half of Springhill map-area, N.S., bounded by latitudes 45° 30′ and 45° 45′ and longitudes 64° 15′ and 64° 30′.

G. W. H. Norman. Mr. Norman continued the geological survey of Lake Ainslie map-area, N.S., bounded by latitudes 46° 00′ and 46° 15′ and longitudes 61° 00′ and 61° 30′.

W. A. Bell. Mr. Bell spent part of the field season in Lake Ainslie district, and Pictou coal field, N.S.

Topographical

S. C. McLean. Mr. McLean ran primary control traverses of the Parry Sound map-area, Ontario, latitudes 45° 15′ to 45° 30′, longitudes 80° 00′ to 80° 30′, and of the east half of St. John map-area, New Brunswick, latitudes 45° 15′ to 45° 30′ and longitudes 65° 30′ to 66° 00′.

H. N. Spence. Mr. Spence ran secondary control traverses of the Parry Sound map-area, Ontario. Mr. Spence also surveyed the geographical control for Michipicoten River map-area, Ontario, latitudes 47° 45′ to 48° 00′, and longitudes 84° 30′ to 85° 00′.

K. G. Chipman. Mr. Chipman completed a secondary triangulation along the shore of Georgian bay within Parry Sound map-area, Ontario. Mr. Chipman also visited the parties in charge of J. W. Spence and J. A. Macdonald in order to supervise the work being carried out by these two officers.

A. G. Haultain. Mr. Haultain continued the work of making control surveys in Copper Cliff map-area, Ontario, latitudes 46° 15′ to 46° 30′, longitudes 81° 00′ to 81° 30′; and in Chelmsford map-area, Ontario, latitudes 46° 30′ to 46° 45′, longitudes 81° 00′ to 81° 30′.

J. V. Butterworth. Mr. Butterworth ran control surveys for Desmeloizes map-area, Quebec, latitudes 48° 45′ to 49° 00′, and longitude 79° 00′ west to the Quebec-Ontario boundary.

J. W. Spence. Mr. Spence topographically surveyed Hillsborough map-area, New Brunswick, latitudes 45° 15′ to 45° 30′, longitudes 65° 30′ to 66° 00′.

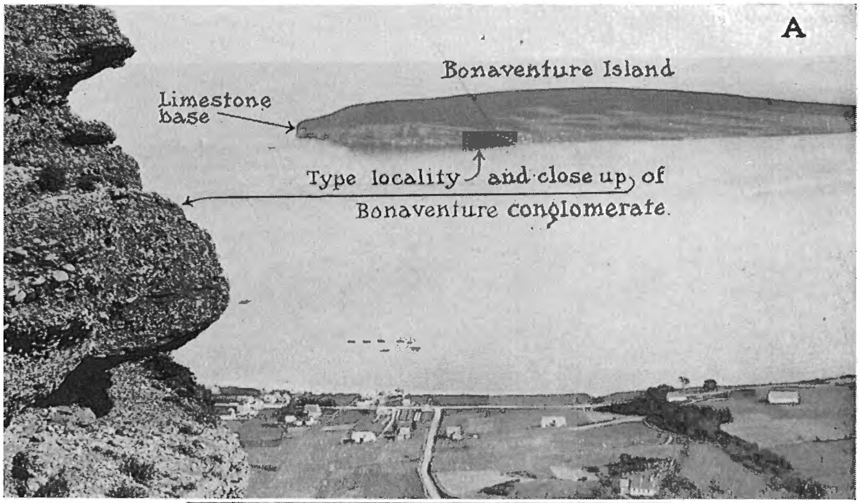
J. A. Macdonald. Mr. Macdonald ran control surveys for the Port Mouton map-area, Nova Scotia, latitudes 43° 45′ to 44° 00′, longitudes 64° 30′ to 65° 00′, and for part of Liverpool map-area, Nova Scotia, latitudes 44° 00′ to 44° 15′, longitudes 64° 30′ to 65° 00′. Mr. Macdonald also completed the running of control surveys of Lake Ainslie map-area, Nova Scotia, latitudes 46° 00′ to 46° 15′ and longitudes 61° 00′ to 61° 30′

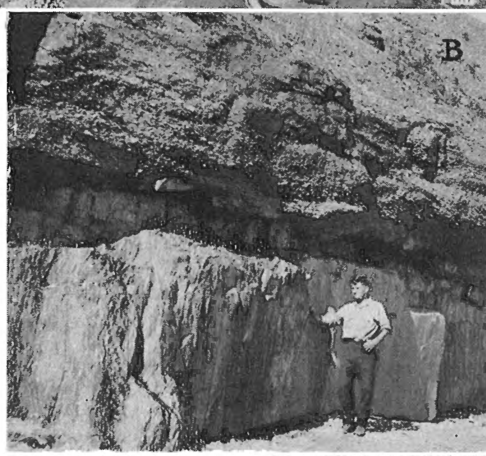
PLATE I

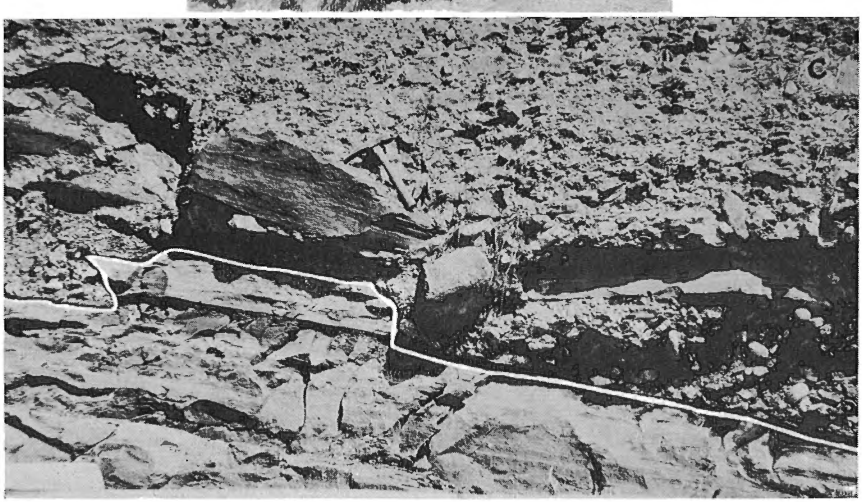
A. View of the type locality of the Bonaventure conglomerate from the shoulder of mount Ste. Anne, with close view of this conglomerate on mount Ste. Anne.

B. Unconformity between Bonaventure conglomerate and Palæozoic limestone; contact 18 inches above head of man. Three miles east of Grand River.

C. Disconformity between the Bonaventure conglomerate and the Escuminac beds, Yacta Point section, Escuminac bay. The large block under the hammer has been derived from the sandstone beds below the disconformity.


A
Bonaventure Island
Limestone base
Type locality and close up of
Bonaventure conglomerate.


B


C

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The annual Summary Report of the Geological Survey is issued in parts, referring to particular subjects or districts. This year there are three parts, A, B, and C. A review of the work of the Geological Survey for the year forms part of the Annual Report of the Department of Mines.