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BELLETERRE AREA, GUILLET TOWNSHIP

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GEOLOGICAL REPORT 55

BELLETERRE AREA

GUILLET TOWNSHIP

TEMISCAMINGUE COUNTY

by

P.-E. AUGER

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INTRODUCTION

General Statement

The discovery of gold in northern Quebec led to the development of a large belt of mineral producing ground which comprises the Noranda, Cadillac, Malartic and Bourlamaque regions. This extends eastward for over a hundred miles from the Quebec-Ontario boundary. North of the main mineral belt, in the Duparquet region, the Beattie and Donchester mines are in operation and south of the main belt, in Guillet township, the Belleterre Quebec mine has been producing gold since 1936.

The writer spent four consecutive field seasons, 1945 to 1948, making a detailed examination of the geology in the vicinity of the Belleterre Quebec mine. Map No. 807, which accompanies this report, covers an area of approximately 35 square miles in the western part of Guillet township and the eastern part of Blondeau township. The area mapped is 6 3/4 miles long from east to west and 5 miles wide. The present detailed geological mapping was undertaken to establish, if possible, the geological conditions governing the genesis of the ore deposits of the region. The main problem was to obtain a clear picture of the structural relationship between the ore deposits and the regional geology. This knowledge may lead to the discovery of other deposits elsewhere in the region where the same conditions and structural relationship are duplicated.

Acknowledgments

During the four years spent in the region, the writer was ably assisted in the field in 1945 by Fernand Desjardins, Raymond Bédard and Carl Faessler; in 1946 by Randolf Hughes, Jean-Guy Gauthier, and André Lemire; in 1947 by Burdett Lee, Jean Dugas, Félix Couture and René Audy; and in 1948 by Burdett Lee, Owen Owens, Thomas Moore, and Arthur Mathieux.

The writer is particularly indebted to the geologists, engineers and prospectors who were engaged in the development of the mineral deposits of the area for the information given generously and

with a real spirit of cooperation. Of particular help were B. Budgeon, Manager, L.S. Trenholme and Jack Plaxton, geologists, as well as K. Godin, W. Disher, W. Flowers and W. Brookbank, all of the staff of Belleterre Quebec Mines Ltd., who supplied the writer with valuable information and extended innumerable courtesies.

Location and Access

The Belleterre area is in Guillet and Blondeau townships, Témiscamingue county. It is about 60 miles south of Noranda and 40 miles east of Ville-Marie. The area can be easily reached by automobile from either of these places. The nearest railway station, about 35 miles west of Belleterre, is Laverlochère on the Mattawa-Angliers branch of the Canadian Pacific Railway.

By air the area is readily accessible, since most of the lakes in the vicinity offer good landing and are interconnected by good motor roads.

By water, the area is most easily reached from Angliers. The route follows Des Quinze and Simard (Expanse) lakes to Klock's bay and thence up Devlin creek to Devlin's lake, which is on the north boundary of Guillet township.

Soil, Timber and Game

The area is overlain by a very thin mantle of sandy soil, which is very poor for agricultural purposes. There is no large tract of land on which farms could be established because the country is hilly and all the relief is due to rock exposures or gravel and sand hills. Most of the low flat ground and the bottoms of most of the valleys are occupied by swamps and muskegs overflowing with water during the wet periods of the year. To the west and north of the area there are some areas of fertile land in which settlers have established good farms. These are located in the Ville-Marie-Lorrainville area to the west and in the vicinity of Simard (Expanse) lake, just north of the area. The former has been settled for over 75 years and the latter is a newly settled area in which additional land is being opened up every year. South and east of the area is wild country where only trappers and prospectors travel occasionally.

The region was at one time an important source of white pine and spruce. Logging operations carried on about 60 years ago removed most of the white pine. Some of the stumps, still standing, measure over 50 inches in diameter. At present spruce and whatever white pine remains are being cut at a fast rate. Forest fires have swept the neighbouring areas on several occasions and in the spring of 1948 all the region to the north and northeast was burned over. Except for occasional small local fires, the Belleterre area has never been affected.

Moose and deer are abundant in the vicinity; black bears are frequently seen and red foxes are quite common. There is excellent fishing in the numerous lakes and rivers. Pike and pickerel of large size abound everywhere.

Previous Work

In 1918 Wilson (1)[x] reached the southeast corner of Guillet township and studied most of the territory surrounding the present area along the main water routes. In 1930 Retty (2) mapped the Gaboury-Blondeau area which is west of Guillet township and, in 1934, he carried out a preliminary exploration of the western part of Guillet township in the vicinity of Traverse lake (3). This was at the time when gold veins were being discovered in the centre of the township where the Belleterre Quebec mine is located. Later, more detailed exploration and geological mapping were done by Henderson (4) (5) in 1935, and by Denis in 1935 (6) and 1936 (7). Trenholme (8) has described the geology of the Belleterre Quebec mine in detail. Prior to completion of the present report the writer has prepared preliminary reports for each of the four years' work in the area (9) (10) (11) (12).

Topography and General Character of the Area

A thin mantle of sand and gravel of glacial and post-glacial lacustrine origin covers most of the area. Practically all of the area is covered with forest, part of which is a new growth. There are clearings at the Belleterre Quebec mine and the townsites of Belleterre and Mud lake. Elsewhere the underbrush is quite thick.

The larger lakes of the area are lakes aux Sables, Chevrier, Gauvin, Guillet (Mud), Twin Taché-Beauclair and Morand lakes.

In addition to these lakes there are numerous small ponds, some of which are dry during the summer season.

The topography of the region is characterized by a very low relief. Lake aux Sables occupies a shallow depression bordered on all sides by glacial deposits. Around the north side of the depression there is a semicircular deposit of coarse glacial material which forms a bench or plateau about 1,500 feet wide and 25 to 50 feet higher than

[x]References are at the end of the report.

the sand plain surrounding the lake. This plateau contains numerous drumlins and moraines which make the topography quite irregular and hilly. On the southwest side of lake aux Sables, in the plain which extends westward from the outlet of the lake, there are numerous ridges of sand 5 to 25 feet high, most of which have irregular branching shapes.

About 1/2 mile north of lake aux Sables there is a chain of hills which extends from the east shore of Beauclair lake to the north-east end of Guillet (Mud) lake. Its elevation is 75 to 80 feet above lake aux Sables. The rocks belong to a volcanic series which underlies this part of the area. Other hills rise out of the granite area south of lake aux Sables. The summits of some of them are close to 200 feet above the level of the lake and their irregular distribution is quite typical of "roches moutonnées" with a general east-west trend.

In the western part of the area there is a series of north-easterly trending ridges. These ridges are not very noticeable on the ground, but are easily visible from the air or on aerial photographs. They are the topographic expression of a system of cross fractures which is quite well developed in this part of the area. Some of the valleys between ridges are gorge-like depressions with vertical walls.

Field-Work

The map of the area was made on a scale of 1 inch equals 500 feet. Base maps were compiled by the Draughting and Cartography Branch of the Quebec Department of Mines from aerial photographs and various surveys supplied by the Quebec Department of Lands and Forests. For the clearing that surrounds the Belleterre Quebec mine, a detailed plane table map was supplied by the company.

In the greater part of the area claim and township lines are well marked. On most of the ground owned by Belleterre Quebec Mines Ltd., Aubelle Mines Ltd., Blondor Quebec Mines Ltd. and Lake Expanse Gold Mines Ltd. north-south picket lines have been cut at 200- or 400-foot intervals for exploration. All these picket lines have been tied in to east-west base lines which in turn have been tied to surveyed claim lines or township lines. Most of the mapping of this ground was done by chain and compass surveys off the picket lines. In other parts of the area east-west base lines were cut at 3,000-foot intervals, the ends being tied to the north-south township lines. Intermediate points along the base lines were tied to claim corners. The mapping was done by running north-south pace and compass traverses, at 500-foot intervals, between the east-west base lines.

Geological mapping was difficult on account of the overburden and the thick underbrush. In places there are numerous rock exposures, but they are so small that it is difficult to obtain sufficient data to determine the sequence of the geological formations. An extensive and systematic search for ore deposits has been carried out on parts of the property of Belleterre Quebec Mines Ltd., Aubelle Mines Ltd., Blondor Quebec Mines Ltd. and several other mining companies. Strippings, trenches, test pits and diamond drill holes are numerous, and furnish a valuable supplement to the information obtainable from natural exposures. In the field most of the exposures were mapped individually but on the accompanying map many of them have been grouped, so that they appear as single large outcrops.

Aerial photographs made by the Royal Canadian Air Force were used extensively to obtain details of topographic features and structural trends. Geological plans prepared by the geologists of Belleterre Quebec Mines Ltd. and Aubelle Mines Ltd. were of considerable help during the underground mapping at these mines.

GENERAL GEOLOGY

The rock formations of the region are all Precambrian in age and range from the older Keewatin-type volcanic formations and allied intrusive rocks to late Precambrian diabase dikes. Most of the older formations, such as the volcanic rocks and the sediments which occupy the base of the series, as well as some intrusive rocks, have been submitted to various degrees of regional metamorphism. The rocks of the younger formations are relatively fresh.

The stratigraphic scale is far from complete; numerous members, which may be found in neighbouring areas, are lacking. Such is the case for the Cobalt sediments and the Paleozoic formations exposed in the vicinity of Temiscamingue lake and the metamorphic rocks belonging to the Grenville sub-province. The basal formations are Keewatin-type volcanic rocks which comprise a series of acid to basic lava flows interstratified with numerous tuffaceous sediments and dioritic sills. Intrusive rocks are varied, and range in composition from lamprophyre and diabase to granodiorite and granite.

The lava flows, together with the interstratified tuff beds, are strongly folded and have a general northeasterly strike and a steep dip toward the south. This structure represents the southern limb of a large easterly plunging anticlinal fold, the core of which is composed of a large mass of granite extending westward for about 30 miles. The outer border of the folded volcanic series is occupied by a narrow band of sediments and another large mass of granitic rocks which underlies large areas to the south, east and north of the region. The intrusive rocks form also numerous dikes and irregular bodies which cut the older formations of the area.

The unconsolidated morainic sand and gravel rest on the eroded surface of the Precambrian rocks. They were deposited in Pleistocene time during the retreat of the continental ice sheet.

The geological succession is given in the following table:

Table of Formations

Quaternary	Recent	Stream, lake and swamp deposits
	Pleistocene	Sand, gravel and boulders
Great unconformity		
Late Precambrian	Keweenawan?	Diabase dikes
Early Precambrian	Post-Keewatin-type and Temiscamian-type?	Veins Lamprophyre dikes Aplite dikes Rhyolite porphyry Granite, granite porphyry, quartz-feldspar porphyry Syenite, feldspar porphyry Quartz diorite, diorite, amphibolite Altered peridotite and serpentine
	Temiscamian-type?	Metamorphosed sediments
	Keewatin-type	Rhyolite Pyroclastic sediments, agglomerate, fragmentals, porphyries Tuff Dacite and trachyte Chlorite schist Volcanic breccia Spotted greenstone Volcanic diorite Andesite Talc-chlorite-sericite schist, serpentine Basalt

Keewatin-type Volcanic Rocks

The rocks classified as Keewatin have a very wide range in composition, appearance and texture. They comprise the whole series from very acid light coloured rhyolite to dark basalt, from very fine grained uniform rhyolite and dacite to coarse porphyritic diorite, from well banded tuff to massive homogeneous volcanic rocks. The intermediate to basic volcanic rocks are by far the most abundant. Massive rhyolite flows are rare. There are also numerous exposures of fragmental volcanic rocks in which the size of the fragments varies from a fraction of an inch to one foot in diameter. The volcanic rocks have most of the common features of the Keewatin lavas. In some places individual flows are recognized mainly by the tuff bands which separate them.

Basalt

Typical basaltic lava is not very common. An exposure of such rock is visible just north of the Flobec Gold mine on the property of Belleterre Quebec Mines Ltd. Some exposures are also visible just south of the Ville-Marie-Belleterre highway, approximately one mile east of Taché lake. Underground at Belleterre, some small flows are basic enough to be classified as basalt; other exposures of basalt are also seen along the west side of Beauclair lake. Several other occurrences of basic rock may be classified in the field as intermediate basic volcanic rocks. These are mostly on the Belleterre property, in the vicinity of vein No. 12, between shaft No. 2 and shaft No. 3. These exposures are not large enough to be separated from the typical andesite on the accompanying map.

They are massive rocks, with none of the usual volcanic features such as flow lines, pillows, amygdaloidal and ropy structure. A study of thin sections shows that some of these basic rocks may be classified as basalt. Under the microscope they are seen to have a fine even-grained texture. As a rule they display a well developed flow texture, characterized by a parallel arrangement of the hornblende needles which, however, are largely altered to chlorite. The rock is composed of 67 to 70 per cent amphibole and chlorite with chalcosodic plagioclase, usually in the form of very fine laths, mixed with epidote, biotite, sphene and apatite. A large number of thin sections from the exposures of so-called basalt from the surface and underground at the Belleterre Quebec mine were found to be andesite. This rock is composed of about 50 per cent chloritic material, the alteration product of hornblende and possibly of pyroxene in some cases.

Talc-sericite Schist and Serpentine

These are found in every part of the area in which volcanic rocks are present. They are the altered equivalent of the various types of volcanic rocks, chiefly of the intermediate and basic types. They usually occur in bands which more or less follow the structure and represent zones of more intense dynamic metamorphism as well as hydrothermal alteration within the volcanic formations. In most of the holes drilled by the Girard Lake Mines Ltd., the volcanic rocks are highly chloritized, especially where they are traversed by numerous granite dikes.

Talc schist, usually finely laminated, is found associated with shear zones. The parent rock may have been either lava or diorite. The rock is very soft and is associated with fine grained intermediate basic volcanic rocks on the south side of range line VIII-IX and with diorite on the south side of the Blondor Quebec property. In both places the schist is associated with faults.

Similar talcose rock is found in several drill holes in the southwestern part of the Blondor Quebec property where it is associated in places with serpentinized volcanic rocks.

Serpentine was found at the surface just south of the VIII-IX range line in the east half of the area. It is an alteration product of either basic volcanic rock or an intrusive peridotite.

Chlorite Schist

Chlorite schist is but a phase of most of the intermediate and basic volcanic rocks of the area. Some of the quartz diorite which will be described below is in places altered to chloritic schist, and since it is impossible to determine contacts between the chlorite schist and the other volcanic rocks, the former was included with the intermediate lava in the accompanying map. It is not found in any great quantity in the area and its distribution seems to be mostly restricted to local structural features like shear zones and faults. Chlorite schist is also more common on the Brenmore Quebec and Flobec properties, just north of Guillet (Mud) lake, where pillow lava is more abundant. In these places the schistosity is parallel to the elongation of the pillows and to the general trend of the structure. In that part of the area the strike of schistosity is N.55°E. to N.75°E. This is also the strike of the Mud Lake fault. A study of thin sections of the schist reveals that chlorite forms more than 50 per cent of the rock. The flakes of chlorite are in and around large grains of ferromagnesian minerals which have been, in places, so completely altered that nothing is left of the original mineral except a faint outline visible only with cross nicols. In most specimens the flakes of chlorite have a definite parallel orientation, especially where they are developed in the groundmass rather than as replacing larger laths of hornblende. The other rock-forming minerals are fine grained altered feldspar, quartz, epidote, apatite and magnetite.

Andesite

Most of the volcanic formations in the area are andesite. In this group may be included all the lavas of intermediate acidity. The andesite may be massive or schisted, even grained or porphyritic, fresh or altered, fine or medium grained. The typical andesite is usually fine grained and is characterized by a dark greenish colour. In most places it is found in the form of lava flows up to a few hundred feet thick. The contacts of these flows are fairly well established in the underground workings at the Belleterre Quebec mine and the Aubelle mine. At the surface it is impossible to outline the lava flows or trace them for any distance along the strike on account of the small size and discontinuity of exposures.

Andesitic lava is the volcanic rock which, in this part of the region, contains the greatest variety of volcanic structures and textures. Pillow structure is quite common in the north central part of the area, especially in a north-south zone extending from Guillet (Mud) lake to Thibault lake. As a rule the pillows are well enough preserved to permit determination of top and bottom. It may be said, however, that where the ellipsoidal structure is more generalized, the pillows are flattened and stretched out considerably under the influence of dynamic metamorphism. Flow cleavage is generally parallel to the elongation of the pillows. There are good exposures of ellipsoidal structure on the 500-foot level north and south of shaft No. 1 and south of shaft No. 3 at the Belleterre mine. On the same level, especially northward from shaft No. 1, irregular bands of carbonate fill the space between the pillows and are useful to indicate the presence of the ellipsoids where their outline cannot be readily seen.

Amygdules are also plentiful in the andesitic rocks, especially in the pillow-rich portions of the lavas. In places there are pillows which have,at their outer border, a layer of closely spaced amygdules 1 to 4 inches thick. In other places large miarolitic cavities are visible inside the pillows. These cavities are usually in the upper half of the ellipsoids. In section they are crescent shaped, with the convex side upward. These cavities are partially filled with quartz. The volume ratio between the cavity and the pillow containing it is approximately constant, suggesting that the gas which accumulated to form the cavity is that which was contained in the lava of each individual pillow. The best examples of this were found on the Flobec property a few hundred feet north of the Guillet (Mud) lake road.

At several places on the Flobec property, just south of the Belleterre Quebec mine, a peculiar linear structure was found in the volcanic flows. It consists of a linear arrangement of amygdules inside individual pillows. The distribution of the gas vesicules may be described as a truncated cone which has its smaller diameter at the bottom and its larger diameter at the top of the pillow. Individual amygdules are themselves lined up and elongated upward in a direction parallel to the sides of the cone. This indicates probably the direction of translation of the gas during the cooling stage of the lava. At very good exposure of this type of structure was found on the Flobec property.

Banding, brecciation and ropy structure are found in several places in the volcanic flows, especially in the andesites. The banded volcanic rocks include material grading in texture from a finely laminated lava to a rather coarse ropy flow top, usually accompanied by breccia. In places the volcanic rock with a ropy texture was used as a horizon marker. One such example may be seen on the Blondor property, where there are three very good exposures of banded ropy structure on outcrops which line up very well along the structure from the south shore to the north shore of Beauclair lake, along the east side of the guest house at the Blondor Quebec mine. This may represent the longest recognizable single flow mapped in the area. A second excellent example of banded volcanic rock is exposed on a cliff in the western part of the area a short distance south of Gauvin lake. At this place the cliff trends about east-west and the banding is north-south, parallel to the structure. Some andesites show a definite porphyritic texture and in places ropy structure was found along with amygdules and pillows.

Numerous samples of andesite lava were studied in thin sections. Most of them are characterized by a definite flow texture in the chloritic alteration products of the hornblende and other ferromagnesian minerals. Hornblende seems to have been the most important constituent, but it is generally partly or completely altered to chlorite. The proportion of amphibole is higher in the andesite in the western part of the area and most of it seems to be secondary. In places amphibole makes up as much as 60 to 70 per cent of the rock. Plagioclase feldspar may form up to 20 per cent of the rock; it is a chalco-sodic feldspar altered to epidote, quartz and sericite. The original composition of the feldspar could be determined in only one thin section and it was found to be andesine (An_{40}). The accessory minerals are epidote, apatite, pyrite and iron oxide. In the porphyritic phases of the andesite the phenocrysts, 3 to 4 millimeters in diameter, are in every case crushed and fractured, but well enough preserved to be identified as andesine (An_{40} to An_{50}). The matrix is very fine quartz, sericite, epidote, chlorite, carbonate and zoisite, all showing a definite flow structure around the feldspar fragments.

Volcanic Diorite

In numerous places the volcanic rocks seem to pass gradually from a typical andesite to a coarser granular rock which has the yellowish colour typical of the diorites in the region. This phase of the volcanic rocks is usually finer grained than the typical intrusive diorite, yet it is generally very difficult to locate a definite contact between the two. The writer believes that, at least in the central part of the area, it is a volcanic rock which has been subjected to thermal action caused by neighbouring larger dioritic bodies. Detailed mapping has shown very definitely that exposures of this phase of the lava, called volcanic diorite in the field, are everywhere clustered around the areas underlain by coarse dioritic masses. The gradual transition from volcanic diorite to intrusive diorite is very striking, but a careful examination of some exposures has revealed the presence of a few sharp contacts between the two rocks. This contact is hardly visible because the two rocks are very similar in appearance and, furthermore, there is usually a narrow shear zone along the contact. In the western part of the area there was no good exposure to show this phenomenon, but in several places the so-called volcanic diorite was found to contain distorted pillows and ropy structure, suggesting its volcanic origin. In places there are fine grained volcanic rocks which grade imperceptibly into dioritic lava and diorite. In other places irregular patches of the volcanic diorite were found in the fine grained lava. At one place, north of the Ville-Marie highway on Blondor Quebec property, a good tuff band may be seen enclosed in volcanic diorite. At another place a volcanic breccia texture may be observed in the same type of diorite.

It is possible that part of the so-called volcanic diorite is actually a lava which has been injected underneath the already solidified surface lava. Under this protective blanket it has coloured more slowly and has developed into a coarser rock of the same age as the rest of the volcanic series. This will be discussed later. The diorite lava is thoroughly altered and a microscopic study reveals very little as to its original character. It is composed mostly of secondary hornblende needles and a large amount of chlorite and epidote, which are probably the alteration products of primary minerals as well as minerals of anamorphic origin.

Spotted Greenstone

There are extensive exposures of spotted greenstone in the northern part of the area. It forms a band, approximately 6,000 feet wide, north of the Ville-Marie highway, and can be followed as a discontinuous zone from Taché lake eastward as far as the boundary of the Belleterre property. The best exposures are on the Conway, Paquin, Ortona and Aubelle properties and the northern part of the Belleterre

Quebec property. Other smaller exposures are found in the central part of the area north of lake aux Sables and at several other localities.

The spotted greenstone is everywhere found with the volcanic formations to which it belongs. It is greenish to dark, massive in appearance and coarser grained than the andesite and basalt described above. Its most striking feature is the presence all through the rock of dark spots ranging in size from 1/8 inch to 1/2 inch. In places, especially in the northwestern part of the area, these spots are so closely spaced that they form more than 75 per cent of the rock. On weathered surfaces the spots are slightly in relief and their colour is more in contrast with the remaining portion of the rock than on a fresh surface.

In thin sections the spots are found to be composed mostly of irregular aggregates of secondary hornblende and chlorite with a little feldspar and quartz. There is also some tremolite and actinolite in radiating needles partly altered to talc, epidote and calcite. These aggregates do not show any definite contacts with the rest of the rock but grade into the "matrix" which contains about the same constituents together with, in places, abundant epidote (giving the rock a green-yellow colour) and smaller amounts of ferromagnesian minerals. Leucoxene, magnetite and calcite are also present. Microscopic determination,as well as field observations,indicates that the spotted aspect of this greenstone is due to metamorphism which caused a recrystallization of the original rock. As a result of this, the hornblende crystals in the spots are fresh-looking and have all the characteristics of secondary minerals In some specimens the spots were found to be composed of just one or two grains of relatively fresh hornblende which has been subjected to limited cataclastic effects such as crushing of the edges, rotation with S-shaped structures, and development of "tails" composed of fresh grains of hornblende crystals drawn out along the lines of schistosity in the matrix.

As for field evidence it is sufficient to say that the farther north in the area and the closer we are to the granite intrusions the more frequent and extensive are the outcrops of spotted greenstone. The nature of the original rock which was thus metamorphosed into spotted greenstone is a problem still unsolved. Field relations suggest that it is an altered intermediate to basic extrusive rock or a diorite either of extrusive or intrusive origin.

Volcanic Breccia

Flow top breccia is visible in several places in the area. It is usually in andesitic rocks, frequently in the vicinity of strong shear zones or at least sheared flow contacts. Very good exposures of volcanic breccia may be seen on the south central shore of Morand lake, in C.1237, claim 5, and C.G. 125, claim 2, on the Conway property; also in numerous places along the north side of the Mill Creek fault and north of Guillet (Mud) lake on the Brenmore property.

Aside from this flow top breccia , there are extensive bands of breccia, especially in the southwestern part of the area. One of these extends eastward from the east shore of Girard lake for a distance of approximately 2,200 feet. It is about 2,000 feet south of the VIII-IX range line in Blondeau township. Another such band is in the southern half of the Guillet Gold Mines property. It extends westward and southwestward along the structure from lake aux Sables for a distance of 2,000 feet.

It is possible that the Girard lake breccia band is an extensive flow top. It is exposed in places on the north face of a high easterly trending cliff. On top of the ridge, overlying the breccia, there is a coarse volcanic diorite which may possibly be the base of another flow. The lake aux Sables breccia band is associated with tuff bands which occupy the central part of the Guillet Gold Mines property.

The breccia consists generally of andesite and trachyte fragments in a matrix of similar composition. The rock contains a large number of amygdules which give it a porous and spongy appearance. The matrix,as well as the fragments, is fine grained and the latter are somewhat lighter in colour on the weathered surface.

In the Lac aux Sables breccia there is good banding due to the presence of parallel arrangement and flowage in the matrix as well as the orientation of elongated fragments. This arrangement may be due to tectonic action. At the southern limit of the Guillet Gold Mines property this breccia changes gradually to a massive basic volcanic rock in which the amount of hornblende increases to such an extent that, on the southern limit of the exposures, it looks like a fine grained amphibolite. This may be due in part to the metamorphic action of a large intrusive mass of syenite a short distance to the south.

In addition to the breccia just described, there are several exposures of what may be called vein breccia. The most extensive of these is a short distance south of the Ville-Marie highway, in the western part of the Belleterre Quebec property. This vein breccia outcrops along the south side of a depression which is possibly occupied by one of the tail branches of the Mill Creek fault. The brecciation was possibly caused by the fault.

The rock is composed of a dark green matrix of schisted volcanic rock containing fragments of pink granite porphyry, andesite with small amygdules, and quartz grains up to 1 inch in diameter. The fragments are very angular and the interstices are filled with squeezed-in volcanic matrix showing good flow lines around the fragments. In places the amygdules make up more than 50 per cent of the matrix. The whole rock is criss-crossed by small quartz and carbonate veins.

The breccia cannot be a Keewatin volcanic breccia because porphyry identical to that of the fragments is found just south of the exposure intruding the volcanic rocks. The only possible explanation of the origin of this breccia is that the volcanic rocks, the porphyry and even the quartz veins in this locality have been subjected to a strong crushing movement, probably associated with the nearby fault. This has broken the competent volcanic rocks, porphyry and quartz, into fragments of various sizes,whereas the less competent schistose volcanic rocks were squeezed between the fragments to form the matrix of the breccia. Later a network of fissures were filled with quartz and calcite.

Dacite and Trachyte

In a few places there are small exposures of intermediate acidic volcanic rock which may be classified as dacite. These are distributed at random through the basic volcanic rocks in the form of thin flows, too small and too few to be shown on the map.

The dacite is massive, fine grained and light coloured. A microscopic study shows that it is usually porphyritic, with small idiomorphic crystals of plagioclase in an extremely fine matrix of quartz, chlorite and plagioclase of the same composition as the phenocrysts. A common feature is a trachytic texture with a marked parallelism in the orientation of the phenocrysts. In most of the sections examined the feldspar is oligoclase (An_{30}) which forms more than 50 per cent of the rock.

South of the VIII-IX range line in Blondeau township a few exposures of light coloured dacite were found. In every case they are soft, fine grained and so highly altered that none of the original minerals could be identified. Quartz, sericite, kaolin and talc are the most abundant minerals in these rocks.

Trachytic lava was found in a few exposures in the vicinity of the Mill Creek fault. In hand specimens it is a dark grey, massive rock containing numerous fine needles of hornblende with a linear orientation accompanied by flakes of biotite in a matrix of quartz and fresh albite, orthoclase and celsian.

Tuff

The numerous bands of volcanic tuff are a striking feature in the area. Some of these are silicified so completely that in places they may be mistaken for banded quartz veins. These silicified tuff layers are white and display fine interstratification of magnetite, sulphides and ferrous iron oxides. In some places the amount of magnetite is so great that the tuff bands are called "iron formations" by the local prospectors and geologists. Most of the quartz in the silicified tuff bands is of the white and smoky varieties. In several places, such as the Aubelle vein No. 1 and Belleterre veins No. 5 and No. 14, the veins follow the tuff bands.

In most places the white tuff layers are very good horizon markers. Some of these bands may be traced over lengths of several thousand feet, although they are not exposed at the surface over the whole length, but are found in series of outcrops which can be lined up fairly well. The width of these tuff bands varies from a few feet to over 50 feet. Their strike is that of the local structure and they dip vertically or steeply to the south. In most of them there is a very fine banding which shows locally an intense crumpling of the interstratified sedimentary layers.

Another type of tuff is the non-silicified tuff which Denis (6) p. 65 has called "basic tuff". It approaches the andesite in composition and, if it were not for the bedding planes, the two would be difficult to distinguish. In most places where these were found by the writer, the tuff is more porous than the usual volcanic rock and the grey buff weathering brings out the stratification. This non-silicified tuff is less widely distributed than the silicified type. Some good exposures are visible in the vicinity of the Gainsmoor fault (p. 73) and to the southeast of the western half of Guillet (Mud) lake.

In several places the tuff beds have been subjected to appreciable deformation such as drag folding and faulting. The best examples of intense drag folding are on the Blondor Quebec property a few hundred feet west of the camp on the south side of the highway. On Lake Expanse ground, now owned by Belleterre Quebec Mines Ltd., a series of tuff and fragmental beds have been locally drag folded and the veins appear to be genetically related to this folding.

Pyroclastic Sediments, Agglomerate, Fragmentals

In the southern half of the area, for a short distance north of Guillet (Mud) lake, also across and west of lake aux Sables and everywhere south of Guillet (Mud) lake, bands of silicified and non-silicified tuff are abundant, but here they are accompanied by numerous and extensive bands of fragmental and agglomerate rocks and by pyroclastic sediments. These are found in layers up to 200 feet thick which can be followed in some cases for several thousand feet along the strike. Their trend is parallel to that of the local regional structure. The rock forming this series is more acidic than the volcanic rock exposed in the rest of the area and most of it is definitely of volcanic origin.

The fragmental rocks appear as light coloured bands, almost pure white on weathered surfaces. They form continuous bands up to 50 feet wide which are more extensively developed a short distance south of Guillet (Mud) lake and in the northern part of the Lake Expanse property. They are made up of a very large proportion of acidic fragments, ranging in size from a fraction of an inch to several inches, embedded in layers of volcanic ash. Numerous fragments are porphyritic. Amygdules are common in both fragments and matrix. The phenocrysts in the fragments are quartz and feldspar embedded in a matrix of very fine grained quartz, sericite, chlorite, calcite and feldspar. Muscovite and biotite were observed in several thin sections of the rock. The quartz phenocrysts are well rounded or sub-angular. Numerous feldspar phenocrysts are idiomorphic, but as a rule the crystal outline is rugged and irregular. Most of the fragments have the composition and appearance of the acidic volcanic rock which is exposed in the southeastern part of the area. Practically no basic or intermediate fragments were observed.

Agglomerates are found in places in some of the bands. They consist of blocks, usually acidic in composition, embedded in a matrix of volcanic rock. In places the blocks, some of which are fine silicified tuff, are up to one foot in diameter. In places they form a large proportion of the bed. The agglomerates are usually rich in hydrothermal minerals, such as quartz, which occur in small veinlets throughout the mass. This may indicate that in these places the rock is a vein-breccia rather than an agglomerate. Gold and other metallic minerals were found in some of these facies of the bands.

In places there are well bedded pyroclastic sediments, light coloured and containing fine grained fragments of various composition. These are usually porous and white on weathered exposures and light to dark grey on fresh surfaces. Numerous exposures of such rock are visible on the south shore of Guillet (Mud) lake and farther south. These rocks also contain idiomorphic or partly rounded feldspar phenocrysts, so numerous in places that they form a good proportion of the mass. The same porphyritic rock is seen definitely intrusive as dikes and sills in the volcanic formations of this part of the area.

Rhyolite

Except for a few isolated exposures, rhyolite was found only in the southern part of the area. It attained its most extensive development in the southeastern corner of the region south of Guillet (Mud) lake. Within a mile and a half south of this lake the rock is mostly andesitic interstratified with numerous tuff, fragmental and agglomerate bands. From this point southward to the metamorphosed sediments most of the rock is rhyolitic in composition. The rhyolite is interlayered very irregularly with large quantities of the above mentioned fragmental and pyroclastic rocks. It forms an easterly to northeasterly trending band about 3,000 feet wide and represents the upper part of the Keewatin volcanic belt in Guillet township and probably marks the last phase of volcanism in the region. It is immediately overlain by sediments which, in this part of the area, are conformable with the volcanic rocks.

This rhyolite is light grey to light brown on the weathered surface. It is very fine grained and usually massive, except along shear zones and flow contacts, where it is schistose and, in places, has been completely altered to a yellowish sericite schist. Eyes of blue opalescent quartz are abundant. As a rule the rhyolite is porphyritic, with phenocrysts of bluish quartz ranging in size from 1/8 inch to 1/2 inch. Most are well rounded, but there are a few which still have a good hexagonal crystal outline. Feldspar phenocrysts are visible in places; there are also a few grains of ferromagnesian minerals. The matrix is a glass of very fine grained quartz and feldspar. Amygdules are common, but no other volcanic texture or structure was found.

Field evidence based on structure, texture and petrography lead to the conclusion that the andesites, which form the major phase of the Keewatin volcanic rocks in the northern part of the area, are at the base of the series. Travelling southward we move upward in the stratigraphic column. At Guillet (Mud) lake and southward, the andesite is interlayered with larger and larger amounts of fragmental rocks,rhyolite and acidic pyroclastic rocks. This series is overlain by rhyolite with pyroclastic and fragmental facies but practically no basic volcanic rocks.

Temiscamian-type Sediments

In the extreme southeastern corner of the area there are a few outcrops of well layered sedimentary rocks which overlie conformably the acidic upper series of the Keewatin. Denis (6) p. 67 correlated these sediments with the Temiscamian. The sedimentary series is visible in a few exposures only and is represented by finely banded greywacke which in places is altered to quartz-mica schist. According to Denis, (6) the same sediments extend eastward and northeastward along the outer border of the volcanic series.

Intrusive Rocks

Altered Peridotite and Serpentine

There are several small masses of serpentine on the west side of Belleterre townsite just north of the VIII-IX range line of Guillet township and also in the swamp north of Morand lake in Blondeau township. This rock may form a more or less continuous band trending approximately east-west but exposures are so scarce that they were mapped as isolated masses in the volcanic formations.

The rock is dark and massive and is characterized at the surface by the usual brown weathering and typical irregular cracks which give the exposures a rough surface. Thin section studies of the rock show the presence of large quantities of serpentine fibres together with magnetite, carbonate, and, in places, clinozoisite. There is no clue as to the nature of the primary minerals which were altered to serpentine.

The amount of magnetite is in places large enough to cause considerable magnetic disturbance. Similar magnetic anomalies are observed in swampy areas between Taché lake and lake aux Sables on both sides of the Blondeau-Guillet township line. This may indicate the presence of similar bands of serpentinized basic rock hidden under drift.

Diorite, Quartz Diorite, Amphibolite

There are numerous dikes, sills and irregular bodies of quartz diorite and diorite which cut the Keewatin-type volcanic rocks everywhere in the district. It has always been a problem to determine whether the rock is of extrusive or intrusive origin. In most places the rock has a coarse granular texture; it is very massive and looks like an intrusive rock. Furthermore, it is found in dikes cutting across the structure in the lava flows and also intruding the volcanic diorite described above. In several places the tuff beds seem to cut across the diorite. A possible explanation is that diorite was intruded on both sides of the tuff bed. A glance at the map of the region reveals that, as a rule, the dioritic intrusive bodies follow the structure very closely. This suggests that most of them are well defined sills which only rarely cut across the structure. It is possible that the diorite is about contemporaneous with the volcanic rocks and represents but a final phase of the extrusion. Some of the diorite has all the characters of an intrusive rock and may be considered as such. The question, however, remains open and it is still possible that all the diorite is intrusive and belongs to a later phase of magmatic action. It is found in definite dikes cutting across the structure in pillow and massive lava. About 1,500 feet north of the Blondor Quebec mine buildings, in a long east-west trench, there are several exposures where diorite grades into massive or schisted volcanic rock. In other places in the same trench, dikes of diorite up to 3 feet wide are seen cutting neatly across the structure of the volcanic rocks. At one place, in about the central part of the trench, a dike of diorite contains fragments of the neighbouring volcanic rock. In the southeastern part of the area, just south of Guillet (Mud) lake, the amount of diorite is much greater than anywhere else. It constitutes more than 60 per cent of the formations underlying the area.

A study of thin sections of the diorite shows that it is massive, even grained or porphyritic, containing numerous hornblende crystals usually altered in part to chlorite. The feldspar is usually andesine (An_{40}), numerous specimens having a micropegmatite texture. In the porphyritic diorite there are large grains of quartz, usually partly rounded and very fresh in appearance. The groundmass consists of fine sericite, epidote, quartz, mica, chlorite and carbonate. Some specimens show a definite spotted texture. The spots, when studied in thin sections, appear to be aggregates of hornblende needles which are very likely of secondary origin.

There are metamorphic phases of the diorite and of the volcanic rock which grade into typical diorite or massive volcanic rock. This occurs especially in the western part of the area, where there is an almost continuous band of such metamorphic basic rock between the granite and the volcanic formations.

The rock is coarse grained and very dark and consists mainly of amphibole with some feldspar, quartz and carbonate. A study of thin sections of several samples of this rock reveals that the amphibole is typically secondary, forming approximately 50 to 60 per cent of the rock. Feldspar occurs in the form of a few large crystals and numerous small laths and grains associated with the quartz. Most of the feldspar is altered and replaced by quartz to such an extent that some grains show a pseudomicrographic texture due to replacement by quartz along the crystallographic directions. Some grains of feldspar were determined as andesine (An_{40}).

Quartz forms a fine grained mosaic which is distributed all through the rock. It is possible that dikes or sills of diorite have been altered to an amphibolite-rich rock more readily than the volcanic rocks as evidenced by the sharp contacts of such an altered dike with lava and even some volcanic diorite near the northeast shore of Morand lake. The cause of metasomatism is possibly the granite but further work needs to be done before arriving at any conclusion on this point.

Syenite, Feldspar Porphyry

The intrusive rock found in the southern part of the area extends for some distance south, west and east of the boundaries of the map.

The rock is coarse grained, pink to light grey, and is composed of large crystals of microcline, albite and some orthoclase which form approximately 70 to 80 per cent of the rock. The microcline and albite are quite fresh, whereas the orthoclase is very highly altered to sericite, and is found within fresh microcline or albite crystals in several places. Small amounts of mosaic interstitial quartz may be seen filling the space between the feldspar crystals. Chlorite accompanies the quartz. It fills fractures and seems to replace both quartz and feldspar in many instances. Minor constituents are sphene, biotite and a few grains of apatite. The rock was called syenite in the field. It is quite possible that it is a phase of the larger granitic mass indicated on regional field maps. Porphyritic phases of the same rock are found in the form of numerous dikes which cut the volcanic rocks in the neighbourhood of the larger intrusive mass of syenite.

There are numerous dikes and other bodies of feldspar porphyry in the area. Some of these intrusive masses are quite large, especially in the eastern half of the area. Along the Mill Creek fault, northeast of Belleterre Quebec shaft No. 2, there is a mass of syenite porphyry 3,000 feet long and about 300 feet wide. Another large mass of syenite porphyry is found underground in the Belleterre Quebec mine along vein No. 12. At a point about half way between shafts No. 1 and No. 3 it has a vertical extent of approximately 500 feet. This body of porphyry does not seem to crop out at the surface except as very small dikes visible along the road between the two shafts. These intrusive rocks follow fairly closely the general strike of the regional structure. Vertical sections of vein No. 12 indicate that the porphyry is not conformable to the structure in dip but rather that it follows the vein. Just north of the western part of Guillet (Mud) lake there is another body of feldspar porphyry which seems to be closely associated with a tuff bed, a faulted zone and a quartz vein.

The rock is usually light coloured, almost white and rather coarse grained. The weathering is quite pronounced and about one inch deep at the surface. The bodies of feldspar porphyry in the neighbourhood of the Mill Creek fault and the Guillet (Mud) Lake fault show a definite schistosity with a well pronounced cataclastic structure.

A microscopic study of thin sections reveals numerous phenocrysts of albite-oligoclase (An_{10}) or of orthoclase in a fine to medium grained groundmass which consists of quartz, feldspar, chlorite and sericite. Flakes of biotite are also visible, especially in the Mill Creek intrusive mass and at several other places in the eastern part of the area.

Granite, Granite Porphyry and Quartz Feldspar Porphyry

Granitic rock underlies a large area extending north and west of the area mapped. The belt of volcanic rocks which contains the Belleterre and other ore deposits of the area is terminated at its west end in contact with this intrusive body. The granitic rock is very massive, medium to coarse grained, and light grey to pink in colour. It contains a very large proportion of glassy quartz. Thin sections of the rock show a large amount of fresh quartz, with orthoclase, microcline and sodic feldspars. Ferromagnesian minerals are practically non-existent.

On the surface and in drill holes it is possible to see in places small segregations of biotite and hornblende, but they are not widespread. Pegmatitic phases of the granite may be observed near the north boundary of the Blondor Quebec property, on the north side of the highway, near the west boundary of the map. In this locality the granite shows a definite graphitic texture and contains coarse flakes of biotite and muscovite.

At the contact between granitic and volcanic rocks the latter have undergone a certain amount of silicification which causes the rock to weather with a lighter colour than the rest of the volcanic rocks. Near the contact the granite shows in places a banding parallel to the structure of the volcanic rock even where this structure is not parallel to the contact.

This granite and the syenite body to the south seem to have an important bearing on the structure of the volcanic formations of the whole region, as may be seen on the structural map of the area (Fig. 1) and on the map by Denis of Simard Lake Map-Area (7).

South of Taché lake, along the north side of the Ville-Marie highway, there are numerous porphyritic dikes which are probably apophyses from the main body of granite located to the north and north-east. These will be described below with the granite porphyries.

Porphyries of these types are more abundant in the western half of the area and, like the feldspar porphyry described above, they follow the general strike of the regional structure. Their distribution seems to have a definite relationship to the batholith of quartz-rich soda granite located in the northwestern part of the district. The abundance of quartz-rich porphyry increases gradually as we approach the granitic intrusive body. On the other hand the feldspar porphyry, very poor in silica, seems to become relatively more abundant as we go away from the granitic mass and approach the syenitic intrusive body along the southern edge of the area. This suggests very strongly a zonal arrangement of various facies differentiated from the main batholith.

The quartz-feldspar porphyry is composed of large phenocrysts of feldspar accompanied by partly resorbed quartz phenocrysts. The rock is usually white or pinkish, with hardly any trace of ferromagnesian minerals. In thin sections the rock is seen to be composed of large idiomorphic phenocrysts of orthoclase, albite and oligoclase (An_{20}) with less abundant rounded grains of clear quartz. The feldspar phenocrysts are usually extensively sericitized and carbonatized. The matrix is fine grained and consists of quartz, feldspar, sericite and carbonate with a few grains of chlorite, epidote and apatite.

The granite porphyry, like the quartz-feldspar porphyry, is more abundant in the western half of the area. This rock has been classified with the quartz-feldspar porphyry because the two rocks are very closely associated and in places it is difficult to tell one from the other. The granite porphyry consists mainly of large phenocrysts of quartz, feldspar, biotite and hornblende in a fine groundmass of similar composition. Seen under the microscope, the rock has the same composition as the quartz feldspar porphyry, except for the presence of additional large grains of hornblende partly altered to chlorite and of biotite also altered to chlorite, epidote, calcite and iron oxide.

In numerous places the dikes of quartz-feldspar porphyry and granite porphyry are associated with quartz veins, some of which carry good values in gold. Two of these dikes were observed to grade along the strike into well defined quartz veins. Furthermore, numerous dikes of porphyries of all types are found in the neighbourhood of the important ore deposits in the area. A series of small dikes and irregular masses of porphyry extend in a southeasterly direction from Taché lake to the west end of Guillet (Mud) lake. It is in the neighbourhood of one of these dikes that quartz veins and good values in gold were found at the Beaver dam a few thousand feet north of the Belleterre townsite.

Rhyolite Porphyry

South of the Belleterre Quebec mine, on the north side of the motor road joining the townsite road to the Mud lake road, there is a dike of rhyolite which cuts the diorite in the vicinity of vein No. 5. It is a small dike about one foot wide striking N.40°E. and dipping almost vertically. It is an extremely fine grained, light coloured rock which displays white products of weathering at the surface. A thin section study of the rock shows that it is made up of small idiomorphic phenocrysts of albite in a very fine groundmass which consists of a mosaic of quartz with some feldspar grains. It is possible that this rock is genetically related to the feldspar porphyry described above. .The dike occupies a system of gash fractures striking N.40°E. which are widely distributed in the outcrop and are filled with quartz veins. At one place the dike is displaced a few feet by a fault striking N.70°W. along which there is a dike of lamprophyre which does not quite reach the faulted part of the rhyolite dike. This relationship suggests that the rhyolite is older than the lamprophyre.

Aplite

A few small dikes of aplitic rock were found cutting the granite in the northern and western part of the area and the syenite near the southern border of the area. In both cases the aplite is a fine grained pink rock which, where it cuts the granite, has a composition very close to that of the granite. Where it cuts the syenite the aplitic rock has the same major feldspathic minerals as elsewhere, but it contains smaller quantities of quartz.

Lamprophyre

Lamprophyre dikes are very numerous all through the area, and are more abundant in the northern part. Lamprophyre is one of the youngest rocks of the region. It is found cutting the veins at the surface and underground at the Belleterre Quebec and the Aubelle mines. There are numerous types of lamprophyre which may be grouped into three main classes: mica lamprophyre, hornblende lamprophyre and diorite lamprophyre.

The mica lamprophyre is usually coarse grained and consists mainly of large flakes of biotite which may form as much as 60 per cent of the rock. The mica is accompanied by chlorite, fresh looking quartz, altered feldspar, some epidote and iron oxide. Dikes of this rock up to 15 feet wide are found everywhere.

The hornblende lamprophyre contains a large proportion of hornblende crystals which in some cases are accompanied by small amounts of biotite. At the west end of the village of Mud lake, there is a dike which changes gradually along the strike from biotite lamprophyre at its north end to hornblende lamprophyre about 50 feet farther south. The texture also changes, from coarse and medium grained, to a pegmatitic phase containing needles of hornblende up to 2 inches long. A microscopic study of this type of lamprophyre shows that it consists of large phenocrysts of hornblende, partly altered to chlorite and epidote, in a groundmass of fresh looking quartz and altered feldspar. In places the hornblende is completely altered to magnesium-rich anthophyllite embedded in a groundmass of quartz, sericite, feldspar, and fresh-looking secondary hornblende needles. Fine grained hornblende lamprophyre is found at several places as a clean-cut narrow dike forming the central portion of a wider lamprophyre dike of the dioritic type. Dikes of this type are found cutting the coarse grained diorite on an outcrop situated just south of the Belleterre Quebec mill.

Diorite lamprophyre comprises a variety of dikes ranging from coarse spotted light coloured diorite to fine dark massive andesite and basalt. The name was given to this type of rock on account of its resemblance to diorite. The lamprophyre dikes usually have a definite schistosity or linear arrangement parallel to the contacts with the intruded formations. The diorite lamprophyre is the most abundant of the three. It is found everywhere cutting volcanic rocks, porphyries and veins. Most of the exposures were found in the eastern part of the area. It is quite possible that the lamprophyre is just as abundant elsewhere, but was not recognized because of the absence of good rock exposures. A study of thin sections of this type of lamprophyre reveals that it consists of chlorite, altered feldspar, large quantities of carbonate and sericite and very little quartz. Most specimens display a definite parallel orientation of the rock-forming minerals.

It is quite common to find in any of the lamprophyres described above pebbles of granite, porphyry, quartz or even fragments of greenstone. The pebbles of acidic intrusive rock and of quartz are well rounded and resemble waterworn pebbles. The greenstone fragments are very seldom rounded; they are rather angular blocks or even shreds or slivers embedded in the lamprophyre. This difference may be due to the difference in composition, the volcanic rock being too close to that of the lamprophyre to permit an easy resorption as in the case of the silica-rich fragments. The pebbles vary from a fraction of an inch to almost a foot in diameter. In some dikes only one small pebble is visible in the whole exposed part of the dike. In other places the pebbles are so numerous that they make up almost the whole volume of the dike.

At several places in the northwestern part of the area, where the lamprophyre cuts granite porphyry dikes, angular fragments of granite porphyry are seen embedded in the lamprophyre near the intersections, whereas rounded boulders of the same porphyry are visible at greater distances from the intersections. This indicates that the boulders in the lamprophyre are fragments of rock which were picked up by the lamprophyre, transported over a certain distance and rounded by partial resorption.

Dikes of lamprophyre are often found cutting each other. There is a good example of this at the west end of vein No. 5, south of the Belleterre Quebec property. At this place all the lamprophyre dikes cut the vein and it looks as if the mica lamprophyre is slightly younger than the diorite lamprophyre. At the east end of vein No. 5, a dike of mica lamprophyre cuts one of diorite lamprophyre and both dikes cut the vein. Where they cut the vein the lamprophyre dikes are crushed, twisted and highly weathered and broken down. This indicates that shearing parallel to the walls of the vein has continued after the deposition of the vein and the intrusion of the lamprophyre. This movement crushed the lamprophyre dikes and also allowed hydrothermal solutions or meteoric waters to effect the alteration mentioned above. In the same general area of vein No. 5 there are several dikes of lamprophyre which contain a border zone of amygdules. This rock is more or less restricted to the volcanic belt, yet one dike was found cutting the granite in the northern batholith, along the west boundary of the area, about 5,000 feet north of the contact with the volcanic rocks.

Diabase

There are a few segments of a dike of diabase exposed in the western part of the area. They cross the Ville-Marie highway about 2,000 feet east of the western limit of the Belleterre Quebec property and extend discontinuously in a N.25°E. direction across the Manterre property. This dike is 20 feet wide and has been traced over a distance of more than 9,000 feet. Two large dikes of diabase and a few small masses of similar intrusive rock have been found along the west border of the area. These intrude the amphibolite and possibly the granite. One of them extends from the west end of Morand lake to the south end of Girard lake. At this point it joins another diabase dike which strikes a few degrees east of north and extends northward along the west shore of the lake for 5,000 feet. This dike is just outside of the map. The location and attitude of both dikes seem to be controlled by the regional structure and by the granite contacts. A smaller dike or a series of small masses of diabase aligned in a north-south direction is exposed about 3,000 feet north of the west end of Morand lake.

The rock is dark, massive and medium grained, with a very distinctive mottled appearance on the weathered surface. The weathered zone is 1/8 inch to 1/2 inch thick, and its lower limit is very sharp. It is brick red, in striking contrast with the dark coloured fresh rock underneath.

A thin section study of the diabase reveals that it consists of augite and labradorite crystals, which make up 75 to 90 per cent of the rock. These are accompanied by quartz and small amounts of secondary hornblende, forming a fine grained mosaic or a fine micrographic texture. Apatite, sphene, and magnetite are also present.

The diabase appears to be the youngest of all the formations in the region. It is found cutting lava, tuff, porphyry, and possibly some veins. It is also believed to be younger than the lamprophyre because fragments of this rock are found along the border of some of the diabase dikes.

Pleistocene and Recent

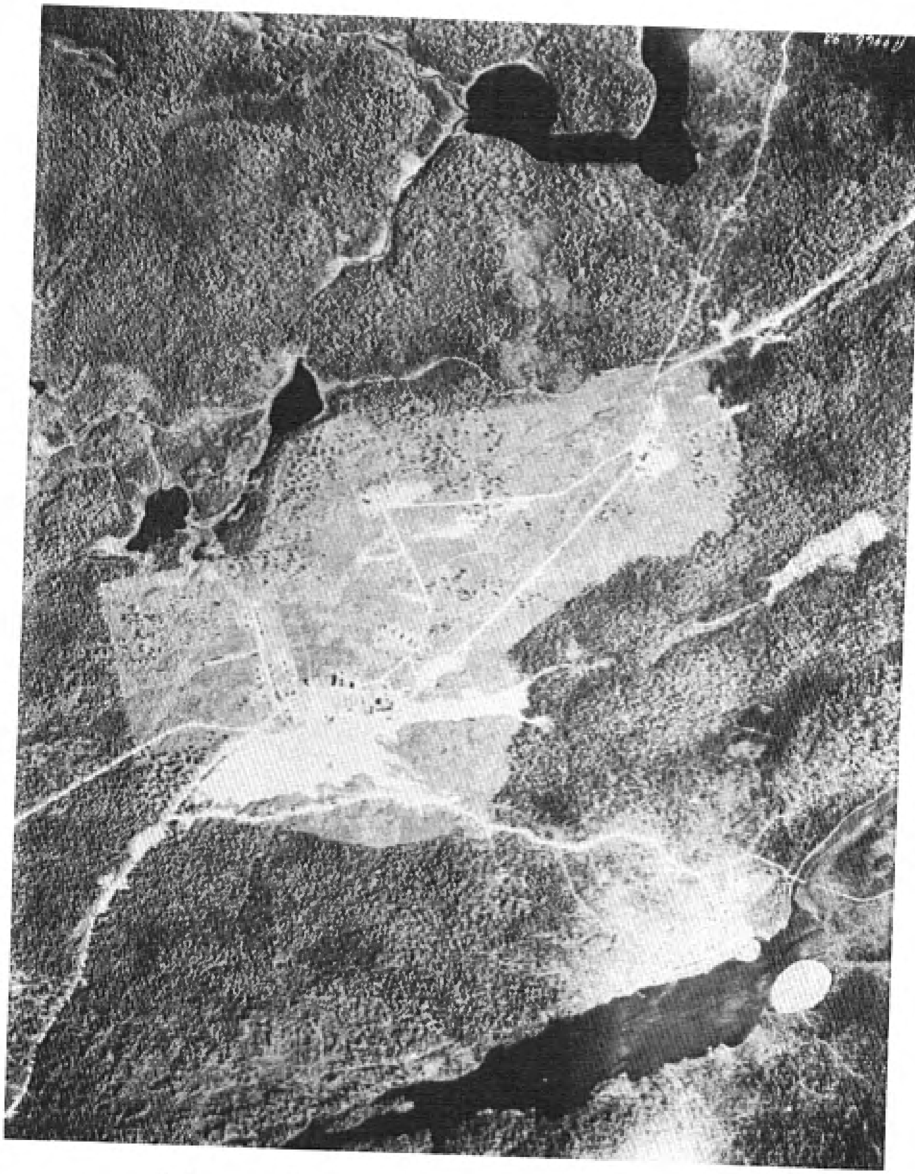
There is much evidence of glaciation in the area. Glacial striae are numerous. They indicate a general south to S.10°W. direction of movement for the glaciers. Numerous gouges and striae are visible on the smooth vertical walls of the gorge occupied by the Gainsmoor fault south of the Ville-Marie highway. The gorge trends S.45°W. It may have been occupied by a sub-glacial stream. All over the area there is a thin layer of glacial débris which consists of sand, gravel and boulders. Varved clay is completely lacking. Eskers, made up largely of gravel, are visible at a few places, but none are of large dimensions. The town of Belleterre, situated on the north shore of lake aux Sables, is built on the beach of a glacial lake which was larger than the present lake. The whole area of the townsite and most of the bottom of Lac aux Sables are covered with fine grained, well sorted sand. The plain southwest of lake aux Sables contains series of low sand ridges trending in a general northeasterly direction but splitting into numerous branches. North of Belleterre there is a semicircular deposit of coarse glacial material in the form of moraines and drumlins which forms a plateau 1,500 feet wide, about 25 to 50 feet higher than the sand plain but lower than the rocky cliffs to the north.

Recent deposits are mostly glacial material which has been transported by streams. Swamp deposits are abundant and consist largely of clayey and organic material.

STRUCTURAL GEOLOGY

A study of the structure of the region reveals that the present area is underlain by rock formations which belong to the southern limb of a large anticlinal fold surrounding the granitic batholith which occupies the northern part of Guillet township and the southern part of Devlin township. The axis of this major anticlinal fold has an east-west direction and, in all probability, plunges toward the east. The southern limb of the fold represents a curved structure with a pronounced convexity toward the south. It is therefore a minor anticlinal fold plunging southward. Its axial plane is

Plate I



Belleterre Quebec mine, viewed from the air.

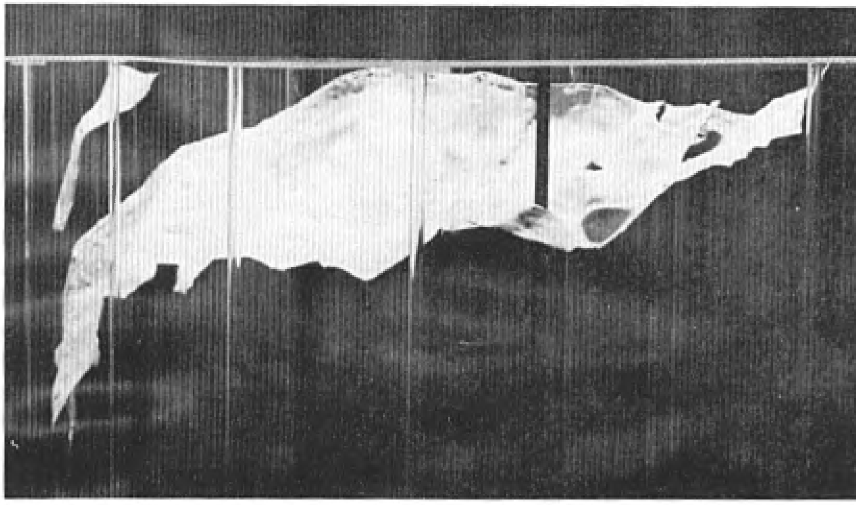


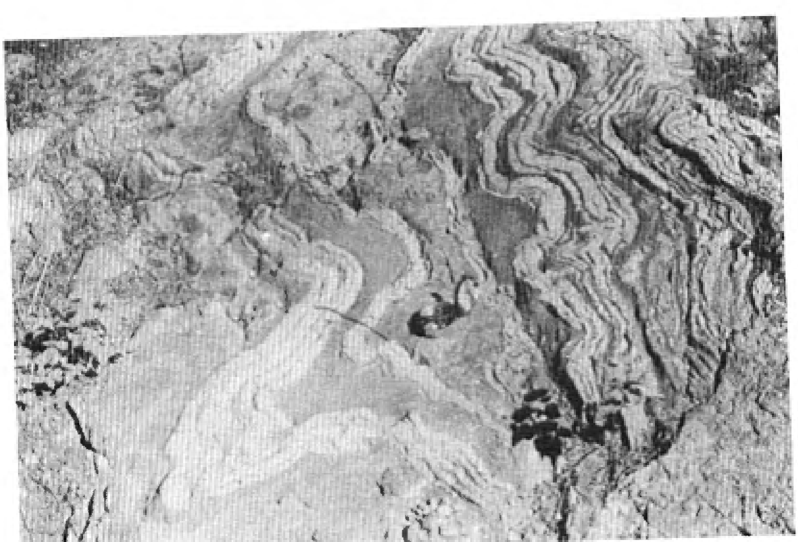
Fig. 2

PHOTOGRAPH (viewed from the north) OF A PLASTIC MODEL SHOWING VEINS No. 12, No. 2, AND No. 20 OF THE BELLETERRE QUEBEC MINES.

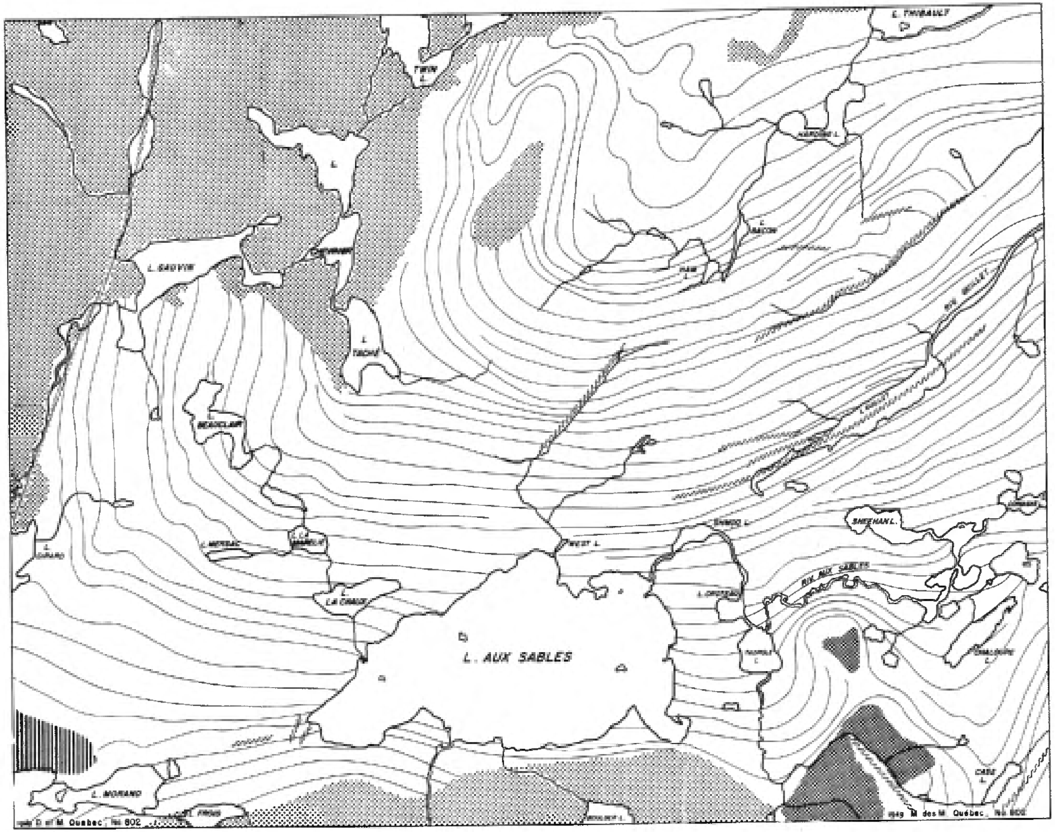
The shaft in foreground is shaft No. 3.
Vein No. 12 is the largest vein (approximately 3000 feet long and extending to a vertical depth of 1300 feet at its eastern end).
Vein No. 2 is above the eastern end of vein No. 12.
Vein No. 20 is visible on the lower levels underneath the eastern end of vein No. 12.
The flat dip in vein No. 12 and the rolls are visible in the No. 3 shaft section. The steepening toward the east of vein No. 12 and its easterly rake are well illustrated.

Plate III

(A) No. 3 shaft, Belleterre Quebec mine.



(B) Crumpled tuff beds south of Taché lake.



LEGEND - *LÉGENDE*

- Diabase / *Diabase*
- Granite, syenite and syenite porphyry / *Granite, syénite et porphyre syénitique*
- Diorite and amphibolite / *Diorite et amphibolite*
- Fault / *Faille*

CARTE STRUCTURALE

DE LA RÉGION DE

BELLETERRE

AREA

STRUCTURAL MAP

P.E. AUGER, 1948

FIGURE No I

close to the east border of the map, where the formations trend approximately east-west and dip steeply to the south.

The attitude of the volcanic flows is clearly indicated by the pillows, which are abundant and well developed, especially in the eastern part of the area. In every case they indicate that the top of the formation is toward the south. In the Belleterre Quebec mine numerous particularly good exposures may be seen in the crosscuts south of shafts No. 1 and No. 3. Here the pillows dip 60° to 70° south and have their tops to the south. In numerous flows the top breccia and the variation of the grain size corroborate the evidence obtained from observation of the pillows. The volcanic formations are in normal sequence, overlain by the sediments to the south and east.

In the western part of the area the strike swings to northwest, north and even northeast. This change in strike of the formations brings them parallel to the contact of the granite which occupies the northwestern part of the area. The structure is parallel to the granite where the contact trends north-south and heads into it where the contact has an east-west direction. West of Gauvin lake the transverse structure crosses the contact and extends for some distance into the granite. The structure of the volcanic formations in the northern part of the Ortona Gold Mines property is affected in the same manner by a small satellitic mass of granite. From the northern extremity of the satellitic mass a zone of intense drag folding extends N.10°E. as far as the contact of the main body of granite. In this zone the axes of numerous minor folds were measured accurately. The axial lines plunge N.20°E. at angles from 0° to 30°. The intense folding and contortion of the lava and the presence of numerous granitic dikes indicate that the intrusive rock is not very far underneath the lava. Some further evidence is supplied by diamond drill hole intersections.

North of Harding lake folds were observed with their axes oriented parallel to the border of the granite mass and plunging 60° to 75° eastward. In the volcanic rocks there is some indication of faulting in which the north side moved upward and eastward. A glance at the structural map (Fig. 1) suggests that the arcuate shape of the structure was caused by an eastward drag from the northern mass of granite.

Near the south border of the area exposures are less numerous and are for the most part acidic volcanic rocks in which minor structural features are less apparent. The general trend, however, is parallel to the intrusive contact.

In the southeastern corner of the region there are several masses of diorite which seem to have uplifted the volcanic beds so that they form concentric rings around the intrusive masses.

Systematic plotting of the data on the attitude of the lava flows reveals the presence of a large drag fold which extends for a distance of 9,500 feet, bearing S.60°W., from Beauclair lake to the north end of Girard lake. The folding increases in intensity and amplitude toward the west.

Faults and shear zones are visible at various places on the surface and underground. They belong to three systems - main fault zones, subsidiary shears, and tension fractures and breccia zones. The fault zones of the first group are possibly the most important structural feature of the area. They may be the governing structural controls of the fault and possibly the vein systems. Mud Lake fault and Mill Creek fault are the two principal fault zones of this type. Mud Lake fault is a shear zone over 100 feet wide which follows about the centre of Guillet (Mud) lake and continues southwesterly in a well defined valley trending N.60°E. The dip appears to be about vertical. Most of the information on this fault was obtained from diamond drill holes. The Mud Lake fault is a zone of intense shearing consisting almost entirely of talc and chlorite schist cut by numerous quartz and carbonate stringers. The shearing has affected the rock formations along the south shore of Guillet (Mud) lake and on the small islands in the lake. The rock thus affected is coarse diorite, in which a strong schistosity has developed parallel to the fault zone. In the neighbourhood of the lake there are several valleys occupied by faults of lesser magnitude belonging to the same system and having the same general trend as the Mud Lake fault. These secondary shear zones are in several places located along tuff bands and are accompanied by small mineralized veins. Diamond drilling across the Mud Lake fault did not reveal any mineralization.

The Mill Creek fault is approximately 5,000 feet north of the Mud Lake fault. Its general direction is N.60°E. although it swings northward at its eastern end. This fault occupies a valley just south of the Belleterre Quebec mill and of shaft No. 2. Holes drilled across the fault zone show that it is 60 feet wide and consists entirely of talc-carbonate-chlorite schist. There are numerous dikes and other masses of porphyry, diorite and lamprophyre along the zone. Mill Creek fault is well defined at the surface by a clean cut valley everywhere along its length. At its west end, however, it branches off into several breaks of less importance. On the south side of Mill Creek fault there is a body of coarse diorite. Along its north side there is a secondary shear and breccia zone following a tuff band and a mineralized quartz vein.

A third fault zone belonging to the Mud Lake fault system is located just north of Belleterre Quebec shaft No. 1. Its topographic expression is a steep cliff in places showing strong brecciation, which borders a swamp extending some distance northward. Underground on the 500-foot level a vertical or nearly vertical shear zone is visible in the crosscut leading northward from shaft No. 1 to vein No. 14. It is 25 to 30 feet wide and does not indicate as much fracturing, crushing and rock alteration as in the case of Mud Lake and Mill Creek faults. Joints, fracture cleavage and dragging in numerous places along this fault zone at the surface suggest that the relative movement has been to the left. A few hundred feet east of the east boundary of the Aubelle property and about 600 feet south of the highway, there are gulleys parallel to Mud Lake and Mill Creek faults. Along the south side of one of these gulleys there is a very striking fault breccia consisting of fragments of quartz, volcanic rock and quartz-feldspar porphyry. The matrix is a network of quartz veinlets with some sulphide mineralization.

Low ground extending from lake aux Sables to Morand lake may represent another fault which could possibly be a branch at the southwestern extension of Mud Lake fault. This is indicated by shearing in outcrops on both sides of the swamps. Other faults and shears are visible on the properties of Blondor Quebec Mines Ltd. and Guillet Gold Mines Ltd. Most of these are roughly parallel to the general trend of the structure.

To the second group, the east-west subsidiary shears and faults, belong numerous shears which are visible on the north side of Guillet (Mud) lake. One of these subsidiary shears strikes a little south of west and seems to join a fault parallel to Mud Lake fault along the north side of the peninsula about 3,000 feet east of the west end of the lake. In a zone 2,000 feet wide on the north side of the Mill Creek fault there are numerous narrow post-vein crushed zones which strike east and dip steeply to the south. Examples of these are the O'Brien and Trenholme faults. Shear No. 4, visible at the surface east of shaft No. 1, is a wide shear zone which has been traced 1,000 feet eastward from shaft No. 1. An intense fracture cleavage has developed everywhere in a wide zone northwest of the Mill Creek fault. This cleavage strikes a little north of west and cuts across the structure. In places this fracture cleavage has developed into narrow zones of shearing which clearly indicate the relative direction of displacement. Such an exposure may be seen 200 feet east of the ore road about half way between shafts No. 1 and No. 2. Here dragging of the beds indicates a right hand displacement.

The third type of fractures, classified as tension fractures and breccia zones, is identified by clean-cut topographic features such as steep sided valleys and steep cliffs. These fractures are oriented N.15°E. to N.40°E. and seem to be related to the large main fault zones. Good examples of these tension and breccia zones are the Gainsmoor fault, at the centre of the map, and possibly two faults of the same type situated south of the central part of Guillet (Mud) lake. A large fault of the same type is located along the west boundary of the area. It follows the valley of the creek joining Girard lake to Gauvin lake and extends for several miles into the granite, trending N.20°E. The topographic expression of this fault is a steep scarp along which a certain amount of shearing may be observed, especially in the basic metamorphic complex which terminates the volcanic belt at the granite contact.

There is no intense shearing and no talc-chlorite zone along these large breaks. Tension cracks are abundant. In the centre of the Gainsmoor fault there is a good clean-cut breccia.

It is possible that the large diabase dike which trends a little east of north occupies a series of overlapping fractures belonging to this group.

Along the north side of the Mill Creek and Mud Lake faults there is a definite change in the strike of the structure in the lava flows and in some of the tuff bands. This change of strike, possibly due to dragging, indicates right hand movement.

In this central part of the volcanic belt there are conflicting evidences for the direction of movement as shown by drag folding lineation and orientation of minor fold axes. Drag folds between Mill Creek fault and Mud Lake fault indicate a left hand movement. The same type of movement is indicated on the east side of the club house at the Belleterre Quebec mine, where a band of tuff has been displaced by a fault roughly parallel to the Mill Creek fault. On the Conway veins, minor dragging in the volcanic formations indicates the same direction of movement along a minor shear. Along the south side of Guillet (Mud) Lake road south of the tailing pond, about 1,500 feet west of the road leading to the Belleterre townsite, drag folds in a tuff band indicate a left hand movement.

The axial lines in all the drag folds plunge to the east or northeast. In the mine, almost everywhere in No. 12 flow, good slickensides indicate that the north side has moved upward.

Away from the central part of the volcanic belt, between the mine and the northern granite mass, the movement on the north side of the faults is everywhere upward and to the east. Toward the south, the movement on the south side of the faults is everywhere upward and to the east. This suggests that the displacement everywhere in the volcanic belt was caused by the intrusion of the large granitic masses to the north and south.

The large shear zones, the most extensive fractures and the ore deposits found to date are all in the central zone. Westward along the strike the large faults and shear zones become less well defined and seem to feather out as we approach the granite contact at the west of the area. What happens to these faults northeastward along the strike, we do not know, but it is possible that the intensity of shearing is maintained or even increased.

ECONOMIC GEOLOGY

Gold is the only valuable mineral which has been produced in the area under study. There is a well recognized structure which controls the known ore deposits, but, up to the present, detailed studies of the structure have been too restricted to permit any kind of generalization.

The gold occurs in the free state, accompanied by minor sulphides, mainly in veins of the fracture or fissure and replacement type. The veins may be classified as conformable, transverse and shear veins. The conformable veins are found in or alongside tuff beds. The transverse veins cut across the structure but are generally confined to a single lava flow. The shear veins follow definite shear zones, generally more or less parallel to the structure. The conformable and transverse veins are the only ones which have been found to contain important orebodies. Most of the veins of the shear type contain some good values in gold, but they are generally narrow and the shoots are too short to be of economic interest. The three types of veins seem to have a definite relationship with the structure and with the intrusive bodies of the area.

Description of Properties

The Belleterre Quebec mine is the only producing mine in the district. Operated by Belleterre Quebec Mines Ltd., it has been producing since 1936. At the Aubelle mine a large amount of underground work has been done on three levels, but the property has not reached the producing stage.

Belleterre Quebec Mines Ltd. (4) (5) (6) (7) (10)

The property of Belleterre Quebec Mines Ltd. covers an area of 850 acres in the east central part of the area. Most of the producing veins are in the eastern part of the area. They occur in a series of basic to intermediate lava flows and in silicified tuff beds which separate the lava flows. The veins are of the conformable, transverse and shear types referred to above.

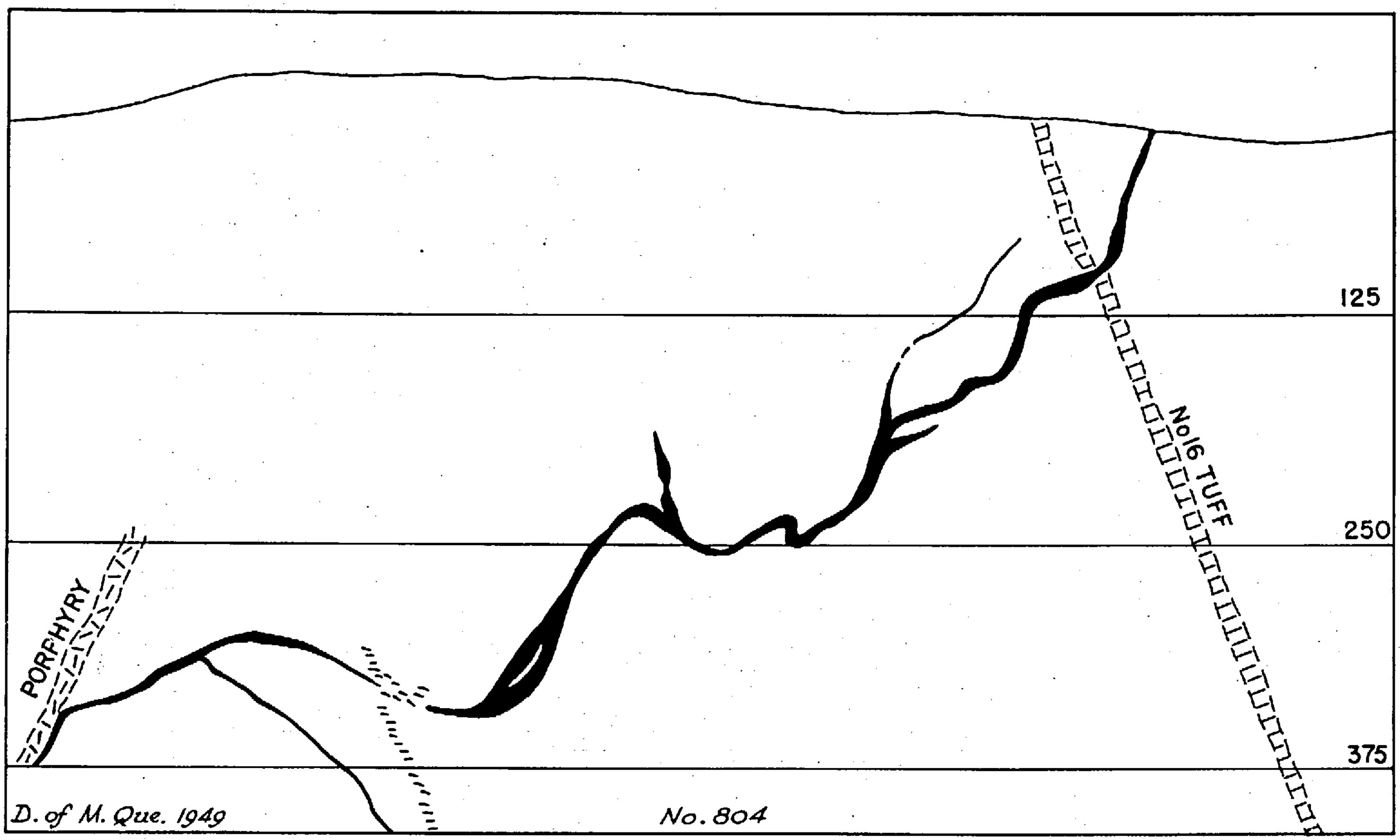


Fig. 2 No. 3 shaft vertical section, across vein No. 12
Belleterre Quebec Mines Ltd.

Transverse Veins

Vein No. 12

Vein No. 12 contains the most important orebody so far developed at the Belleterre Quebec mine. It has been opened up by development headings driven from shafts No. 1 and No. 3 and has been the main source of ore since the beginning of milling operations in 1936.

As may be seen in Plate II, vein No. 12 is a tabular body, very irregular in shape, which outcrops at the surface at its western end. The upper part of the vein has been removed by erosion. Vein No. 12 strikes approximately N.67°E., about parallel to the general trend of the structure in this part of the area. It dips 57° northwest, whereas the formations dip steeply toward the southeast. Vein No. 12 is almost entirely included within an intermediate to basic lava flow or group of flows which, taken as a whole, are called flow No. 12. The foot wall of this lava flow is occupied by tuff bed No. 14 and the hanging wall by tuff bed No. 16. These tuff bands are well defined markers, and were intersected by many of the underground workings and diamond drill holes. They strike N.60°E. and dip steeply to the southeast. The total length of vein No. 12 is a little over 3,000 feet. It has been developed to a depth of 1,300 feet. The width varies from a few inches to 10 feet. Minor fractures and veins branch off the main vein, especially at the western end, where a hanging wall branch extends from the 125-foot level to the surface.

In its western half the vein is quite flat, its average dip in the vicinity of shaft No. 3 being 30° north. The rolls in the vein resemble a series of anticlinal and synclinal folds. These rolls plunge toward the east at a low angle and die out at depth about half way between shaft No. 3 and shaft No. 1. Recent development work southwest of shaft No. 3 indicates that the rolls or pseudo-anticlines and synclines have westerly plunging axes. The general trend of the axes of these rolls is closer to east-west than the vein itself. On account of its flat dip at the western end, vein No. 12, which is limited to No. 12 lava flow, here has a vertical extent of only 375 feet. Eastward from shaft No. 3 the vein becomes gradually steeper and therefore reaches a greater depth before approaching tuff band No. 14 (Fig. 2). A similar change in strike occurs along vein No. 12. Near the surface it is close to tuff band No. 16 and almost parallel to it for most of its length. At depth, the strike of the vein gradually swings from N.67°E. to almost east, the angle at which it cuts across flow No. 12 becoming greater at depth. This explains why the vein, which is within the limits of No. 12 flow, becomes rapidly

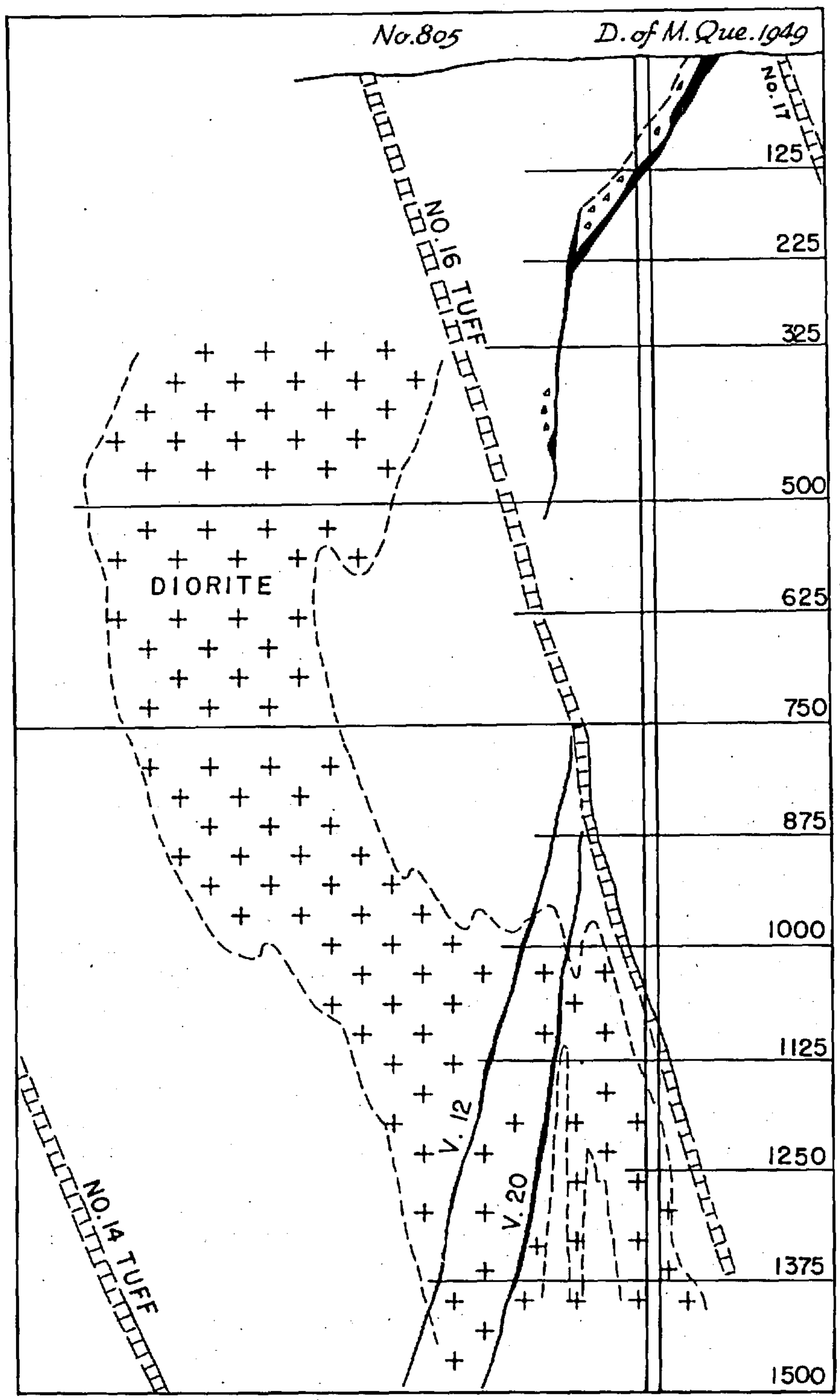


Fig. 3 No.1 shaft vertical section, across vein No.12
Belleterre Quebec Mines Ltd.

shorter at depth. At its eastern end, at a depth of 1,300 feet, vein No. 12 is almost vertical and has been developed over a very short distance only.

Various explanations, including folding of the vein after deposition, fractures in échelon, and conjugate fractures connected by vein matter to form the rolling part of the vein, have been proposed for the formation of the fractures occupied by vein No. 12.

According to Trenholme (8), pp.796-803, flow No.12,which contains the vein, has been submitted to shearing, coupled with the maximum amount of movement along the two limiting tuff beds No. 16 and No.14. The relative direction of movement in the shearing is north side up and this caused a transverse system of fractures to develop across flow No.12. Later,a continued application of this stress caused crumpling and a rotation of the original fractures and a general flattening of the dip. It seems that this process of crumpling, rolling and folding of the fractures was completed before the vein material was introduced to produce the vein in its present state by filling and replacement. This theory, however, does not explain why No. 12 does not behave in the same manner at both ends, and at the surface and at depth.

A careful study of minor structure in underground workings and on the surface at the Belleterre Quebec mine revealed,aside from the large scale structures mentioned above, other features which indicate movements of less amplitude, which may explain the origin of the vein fractures. A thrust from the south has caused everywhere well-developed horizontal crenulation and minor drag folds on the S planes which are parallel to the lava beds. These must be later than the folding and slicing described above and they clearly indicate an up dip movement of the south side in relation to the north side. It is possible that in the flows of proper competency, such as No. 12 flow, fracture cleavage, observed in numerous places, is due to this thrust (see Fig. 5). Since the thrust did not have the same intensity everywhere, the trace of the fracture cleavage in plan forms a small angle with the strike of the formations.

Later, possibly during the cooling stage of the granite masses, there was a release of pressure. Readjustment took place by slipping, under the force of gravity, along some of the S planes.

This readjustment took place under the considerable pressure of the weight of the formations resting and slipping on the S surfaces.

Evidence of this later movement is shown by the slip surfaces and slickensides observed on the S planes and on which the

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south side has moved down the dip in relation to the north side. During this movement the fracture cleavage formed during the first stage was sliced, deformed and possibly opened up to provide fracture openings for the No. 12 type veins.

Even along the vein surface a small amount of movement, south side down, may have taken place. This may account for the well formed rolls and apparent folding on the vein walls if the movement continued during and after deposition of the vein filling.

It seems probable that the release of pressure was greater at the western end of vein No. 12 than at the eastern end. This produced a greater flattening in the vein, more important rolling and a larger number of horizontal joints. This gravity movement was not uniform all along the length of the vein. A large number of observations made by the writer on the 500-foot level in lava flow No. 12 indicates that the movement (south side down) had a greater intensity at the western end of the vein than at the eastern end. This caused an apparent movement of rotation between the S planes. This theory is based on the fact that the striae due to this last displacement change in plunge from 35° east, near shaft No. 3, to 85° east near shaft No. 1.

It is very likely that mineralization accompanied this last stage of movement rather than the first. If such is the case, there are two possibilities which may be worth considering in the search of new orebodies.

1) The zone of maximum release of pressure (western part of the vein) would be the most likely place for a repetition of the fractures and veins at depth in No. 12 flow and possibly in others.

2) Toward the northeast, along the strike of the formations, there may be other zones of maximum release of pressure. These may be indicated at the surface by the presence of flat joints and deformed fracture cleavage.

Vein No. 12 consists of bluish to smoky quartz, massive in most places and containing numerous inclusions of wall rock. It is believed to be of the fracture filling replacement type. Pyrite, pyrrhotite, sphalerite, galena and chalcopyrite are present in small amounts at numerous places. Free gold is not uncommon. The values are persistent all through the vein and the ore has an average grade of half an ounce of gold per ton.

Vein No. 2

At the eastern end of vein No. 12 and above it, that is, above tuff band No. 16, is another transverse vein which behaves in a similar fashion to vein No. 12. It is vein No. 2, which appears along No. 16 tuff band and swings to the southeast across the flow. At the surface, vein No. 2 and vein No. 12 are quite far apart. As vein No. 2 is followed down dip it becomes gradually closer to the eastern end of vein No. 12. On the 500-foot level, the two veins are approximately opposite each other on either side of No. 16 tuff band. In a vertical section, at this place, the two veins look like a single vein divided into two sections by the tuff bed. Vein No. 2 was opened up on 5 levels over lengths varying from 290 to 500 feet. It extends from the surface near shaft No. 1 to a depth of 600 feet. It has a general S.70°E. strike, dips steeply to the northeast and has a width of a few inches to 6 feet.

Vein No. 20

This vein was discovered recently and little development has been done on it. It is situated south of and underneath the eastern end of vein No. 12, in No. 12 flow. The two veins, No. 12 and No. 20, are limited at the top by No. 16 tuff bed and vein No. 12 peters out at depth, whereas vein No. 20 seems to become slightly longer and may possibly represent an échelon fracture system extending downward. On the 1,500-foot level, where it is well exposed, vein No. 20 is seen to occupy a fracture showing evidence of shearing in greenstone, diorite and porphyry. It strikes about east and dips 85° north to vertical. The shear zone is 10 to 15 feet wide and the vein consists of irregular lenses of quartz which overlap each other along the shear and, in places, show a definite beaded structure.

Structurally, vein No. 20 is similar to vein No. 12. It belongs to the same type of fracture system. On the 1,500-foot level, in the shaft section, vein No. 20 is about 200 feet north of No. 16 tuff bed. As we move eastward along the strike of the vein, we reach the intersection of the two. At this point the vein stops abruptly. The east end of vein No. 20 rakes steeply eastward along the line of intersection of the vein with No. 16 tuff bed. At the west end, the ore shoot of the vein rakes eastward also, but at a lower angle, resulting in a lateral shortening of the ore shoot at depth, although the vein itself becomes longer. The vein filling is somewhat glassy quartz of the dark grey variety. It contains in places large amounts of sulphides, mostly pyrite, accompanied by pyrrhotite, chalcopyrite and sphalerite. This last-mentioned mineral is abundant in the richer parts of the vein. The country rock in the shear between the quartz lenses is strongly mineralized and is said to have given good assays

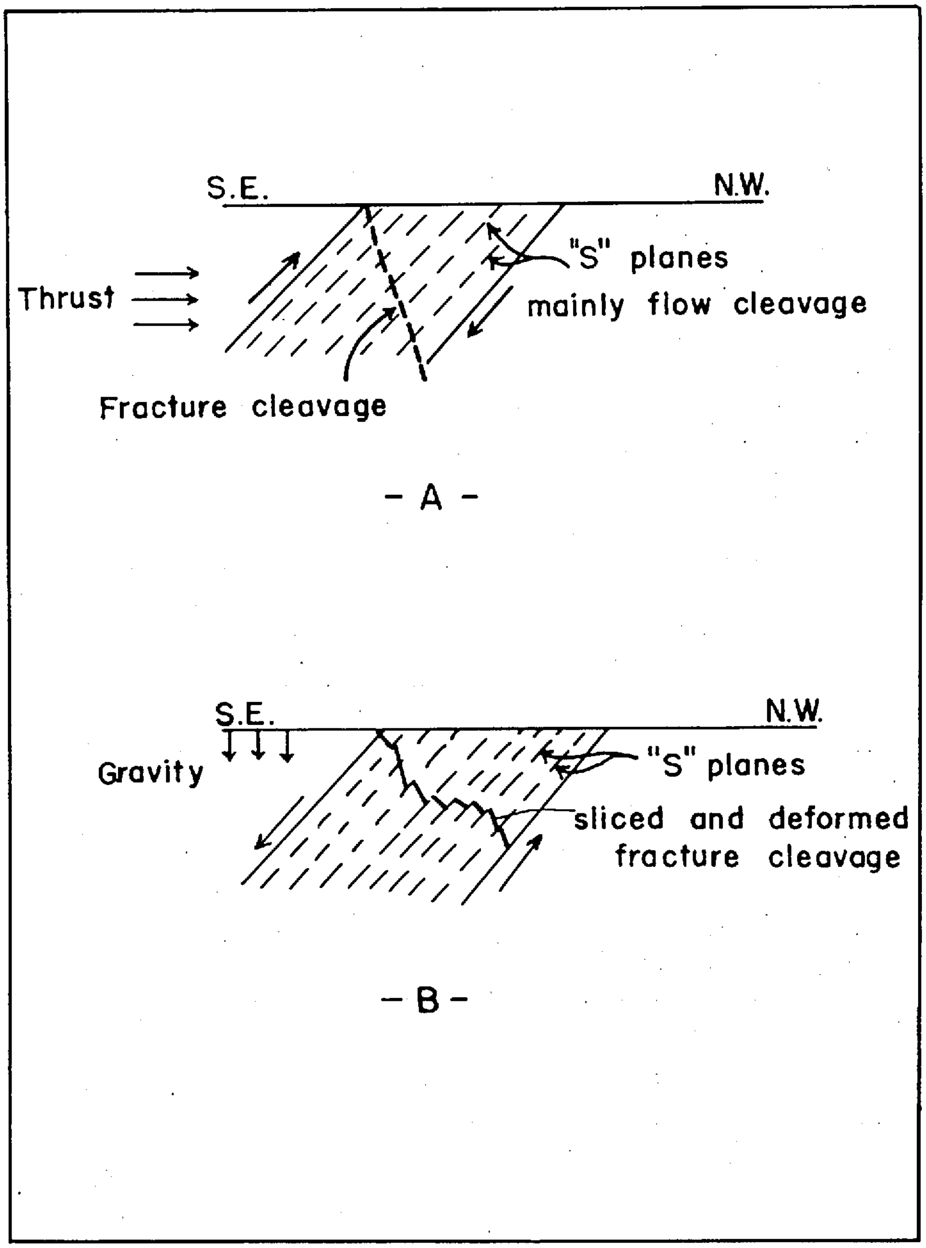

Fig. - 5 POSSIBLE ORIGIN OF THE VEIN FRACTURE
BELLETERRE QUEBEC MINES LTD.
D. M. Q. 1951 No. 923

in gold. It is thought that the gold occurs along the numerous narrow stringers which cut across the rock. The most important ore shoot in the vein, as far as is known at the present stage of development, is on the 1,500-foot level in the most westerly 300 feet of the drift. The grade is about half an ounce per ton over a width of 3 1/2 feet.

Vein No. 11

Vein No. 11 and vein No. 2 were the first veins of economic importance to be discovered. Vein No. 11, which is in the vicinity of shaft No. 2, is practically on the westward projection of vein No. 1, which will be described below. It consists of white and smoky quartz, containing very little sulphide minerals. It lies in an andesite flow, and appears to have the same relationship to the tuff beds as the other transverse veins. In places, feldspar porphyry forms the hanging wall of the vein. At the surface, due north of the mill, a dike of porphyry is seen cutting across the vein. Vein No. 11 strikes northeasterly and dips about 50° southeast. At the surface and on the upper levels the vein has a reversed S shape which may suggest a drag fold origin of the fissure. As the vein is followed down dip, the "drag fold" aspect becomes less pronounced. On the 500-foot level the vein is lenticular and approximately straight, striking in a general northwesterly direction. According to Bishop (13), the drag-folded shape of vein No. 11 is due to the fact that the vein consists of two easterly trending segments connected by an arcuate, irregular and discontinuous segment which strikes southeast. Each of the three segments has a length of about 190 feet. It is possible that a detailed analysis of the structure of this vein will reveal that the drag-fold shape is the same type of structural phenomenon as the rolls in vein No. 12.

Vein No. 11 has been explored by drifting on the 125-, 250-, 375- and 500-foot levels, over lengths of approximately 500 feet. In places it consists only of stringers, but in other places it has a width of 10 feet.

The three transverse veins described above are quartz veins containing free milling gold and some sulphides. The quartz is grey to bluish, smoky in places and very fine grained. The most common sulphides are pyrite, pyrrhotite, sphalerite and chalcopyrite. Sphalerite is often found associated with the better-grade ore.

Tuff Veins

These veins are the most abundant in the district. They are intimately associated with the silicified tuff beds which are interstratified with the lava flows in the region. The veins are conformable with the tuff bands. They consist of blue to bluish white quartz accompanied by some sulphide minerals. They are replacement veins which generally show good banding whether they are in or alongside the tuff beds. In places, the tuff is almost completely replaced by the quartz, in which banding is still visible. As a rule, this type of replacement vein has a more cherty appearance than the other quartz veins of the region. In a few instances narrow lens-shaped quartz veins fill fractures in or alongside the tuff beds.

Vein No. 14

Vein No. 14 is 700 feet north of vein No. 12 on the 500-foot level. It is a quartz replacement type vein, along a shear zone in a brownish rock of sedimentary origin, accompanied by lenses of silicified tuff in what is known as the No. 14 horizon.

It strikes N.50°E. and dips about 70° southeast. The vein has been explored on several levels from the 500-foot level down to a depth of 1,500 feet. At its maximum depth it joins fractures belonging to the No. 12 system, but it is not possible at this point to determine the exact relationship between the two veins.

Vein No. 14 is exposed in the drift on the 500-foot level for a length of 865 feet. Ore shoots vary in width from a few inches to 5 feet on the upper level and to 8 or 12 feet on the lower levels. On the 1,500-foot level, the vein contains gold of ore grade, together with considerable sphalerite, for a length of 350 feet.

Vein No. 16

This vein is associated with the No. 16 tuff bed which limits the upper extensions of veins Nos. 12 and 20. It has been explored chiefly in places where vein No. 12 touches tuff bed No. 16. It seems that there are several veins which accompany the No. 16 tuff band. These veins have been opened up, mostly on the 750-foot level, for a length of 430 feet with widths ranging from a few inches to 3 feet. The veins have been opened up over short lengths on the 1,000- and 1,300-foot levels. The quartz which replaces the tuff contains some visible gold and gave good assays.

Vein No. 18

This vein is opened up on the 500-foot level for a distance of 245 feet. It consists of quartz in and along No. 18 tuff bed, 1,000 feet south of No. 16 tuff band. The width of this vein varies from stringers up to 5 feet. Drill hole intersections above the 500-foot level show that the vein extends toward the surface, but very little is known about its size.

Vein No. 1

This vein follows a tuff band which extends east of shaft No. 2, along the north side of the Mill Creek fault. It is exposed in trenches for a distance of 1,500 feet, mostly within the tuff band. The width ranges from a few inches to 20 feet. The vein consists of smoky quartz and contains some sulphides. Gold is reported throughout the vein.

Shear Veins

Vein No. 5

This vein is about 1,000 feet south of shaft No. 2, along the motor road leading to Guillet (Mud) lake. It strikes east and dips 50° south to vertical. The vein is exposed at the surface and was explored by diamond drilling for a total length of 950 feet. The width varies from a few inches to 3 feet.

Samples taken from the surface contained good values in gold.

Conway Veins

These veins are in the western part of the Belleterre Quebec property on claims formerly owned by Conway Gold Mines Ltd. There are three principal veins, all of the shear type.

One vein is in the north half of C.1237, claim 1, another is in the south half of the same claim, and a third is in the north half of C.G.125, claim 2.

The first vein mentioned above is the most important. It was traced for a distance of more than 1,000 feet. It strikes slightly north of east and dips steeply to the south. The width of the vein varies from a few inches to 4 feet. It is almost everywhere a clean-cut vein with well defined walls.

The vein consists of white and blue quartz containing a small amount of sulphides, mostly pyrite, with some chalcopyrite, galena, and sphalerite. It occupies a shear zone along which left hand displacement has taken place. The wall rock is basic lava with a few tuff bands. The structure in this part of the property is definitely oriented toward the northwest and is transected by the shear which contains the vein.

Approximately 500 feet south of the large vein just referred to, another vein is exposed in the south half of the same claim. It is much smaller than the first, being about 300 feet long; it strikes a little north of west. This vein follows a strong shear zone which seems to be parallel to a wide irregular tuff band inter-bedded with the basic volcanic flows. The vein is very irregular and, in most places, becomes a series of quartz veins or lenses injected along the structure over widths ranging from 2 to 15 feet. This zone generally contains abundant sulphides, mostly fine grained pyrite. The vein is associated with lamprophyre dikes.

In C.G.125, claim 2, 600 feet west of the west end of the first mentioned vein, there is another vein which may be on the continuation of the same fracture. This vein is about 300 feet long. It strikes approximately east, but is very irregular and lens-shaped, with a maximum width of 2 1/2 feet. It dips steeply to the south and intersects basic volcanic rocks with good banding and, in places, a definite schistosity striking a little east of north. This vein is intersected by a lamprophyre and a porphyry dike. Surface work and diamond drilling in this vein indicated good values in gold.

Lake Expanse Property

The property comprises 13 claims situated on the south-east side of Guillet (Mud) lake. It now belongs to Belleterre Quebec Mines Ltd.

The claims are underlain by alternating bands of tuff, greenstone and diorite. The structure generally trends northeast.

Gold has been found at widely separated points along a belt of tuff and basic lava in the north central part of the property. The mineralized zones consist of quartz stringers and sulphide re-placement in country rock. They seem to be related to bands or drag folds in the structure. The most important is the No. 1 zone, in the western part of the property. It consists of a series of drag folds and shears in which small lenses of quartz and a fair amount of sul-phide may be seen for a distance of about 400 feet. The zone trends north-south and has a width of 20 to 30 feet. It contains pyrite, chalcopyrite, pyrrhotite, galena, and sphalerite. Free gold was found at several places in the quartz. The high gold values are associated with the sphalerite-galena mineralization. Extensive drilling on this zone indicated, at the southern end, numerous small mineralized veins containing encouraging values in gold.

Vein No. 25 was discovered by the writer in 1945. It is about 100 feet south of zone No. 3, and 700 feet southeast from the northwestern corner of claim R.20393. The zone contains a series of lenticular veins of smoky quartz, irregularly distributed in a brecciated tuff or fragmental rock cemented with quartz. The veins contain galena and high values in gold although no visible gold was found.

The other zones are nearly of the same type, but not so extensive as No. 1 zone. Some of them carry gold in commercial amount at the surface.

Aubelle Mines Ltd.

The claims held by this company are numbered R.20377 to R-20386. The property is just west of the Belleterre Quebec mine.

The company has sunk a vertical shaft to a depth of 500 feet and has driven more than 3,000 feet of drifts and cross-cuts on the 250-. 375- and 500-foot levels.

The rock formations are basic volcanic flows interstratified with tuff beds and intruded by large masses or sills of quartz diorite. The main geological feature of the mine is a wide tuff band which is interstratified with the basic lava flows. This tuff band has been followed in an east-west direction at the surface for a considerable distance. Underground it has been exposed over a length of more than 1,100 feet. The width on the 500-foot level varies from 20 feet at the east end to 100 feet at the west end. The tuff is light coloured, well stratified and highly silicified. At numerous places the tuff is crumpled and folded, especially along its southern contact. The dip of this contact is about 75° south. In the shaft section the dip, which is vertical from the 250- to the 375-foot level, and 60° from the 375- to the 500-foot level, indicates the presence of a roll.

There are three principal veins on the property. Vein No. 1 is situated about 600 feet north of the Belleterre-Ville-Marie highway. It strikes east and dips steeply south. The vein has been traced for a distance of over 1,000 feet and found to have widths varying from a few feet to 10 feet. It consists of quartz, in places well banded, containing small amounts of pyrite and chalcopyrite.

A large body of coarse diorite, seen at the surface and intersected by several diamond drill holes, lies approximately 250 feet south of the vein. It is about parallel to the general structure of the region which strikes east at this point.

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Porphyry intrusive bodies are abundant. They occur in the form of irregular dikes and masses, ranging from a few inches to 100 feet wide, which cut across the structure. The porphyry is a granite porphyry, light coloured and quite coarse grained. Wherever quartz veins cut the porphyry there is a definite pink alteration zone on each side of the vein. This zone is from 1 to 4 inches wide and shows in places well developed feldspar crystals of secondary origin. The most important masses of porphyry are two dikes striking N.75°W. and dipping steeply northeast. On the 500-foot level the tuff bands are displaced at the dikes, yet there is no definite fault visible underground or at the surface along which such displacement may have taken place.

Lamprophyre dikes are found everywhere in the mine, especially in the vicinity of the veins. They are of the typical biotite and hornblende types, and cut across the veins and all the rock formations present.

Vein No. 1, on which all the development has been done, is essentially a conformable vein which follows a narrow break in the tuff bed at a short distance from its southern border. The minor shear zone along which the vein is located seems to indicate a small left hand displacement. The vein consists of lenses of white glassy quartz containing disseminated sulphides. These lenses may be a few feet to 200 feet long and a few inches to 6 feet wide. In places, especially east of the shaft on the 250-foot level and west of the shaft on the 500-foot level, the vein contains large quantities of sulphides. These are mostly pyrite, pyrrhotite and sphalerite, with some chalcopyrite and galena. The gangue is a mixture of quartz and carbonate. There is a later generation of white quartz which contains some galena and which cuts across the older veins.

In the volcanic rocks the vein and the break are well defined and easy to follow. In the porphyry the break alone is visible as a series of tension cracks in échelon formation oriented in such a way that they form an angle of 25° to 45° with the general trend of the break. These tension cracks are filled with white quartz and contain, in places, some sulphide but no gold.

Development to date has proved that there are ore shoots containing gold in commercial quantities in vein No. 1 but these ore shoots are small and erratic.

Vein No. 2, directly south of vein No. 1 and about 700 feet south of the Belleterre-Ville-Marie highway, strikes east and dips steeply south to vertical. It has been traced at the surface in trenches and underground by diamond drill holes for a distance of more than 1,000 feet and found to have a maximum width of 9 feet. It is

Figure 6

found in diorite and volcanic rock with some lamprophyre dikes and tuff bands. The vein follows a series of parallel shear zones which are, in turn, parallel to the structure. Vein No. 2 is terminated at its east end by the Gainsmoor fault. At 400 feet west of its west end, there is a vein uncovered in a few trenches which may be its westerly extension. The quartz is of the white and blue variety with a certain amount of sulphides. The vein, especially toward its east end, is very rusty and consists mostly of quartz interbanded with silicified tuff.

Another vein, designated as the New Vein, lies south of the west end of vein No. 1, about 200 feet north of the Ville-Marie highway. It was traced at the surface for a distance of 450 feet and found to vary in width from a few inches to 5 feet. This vein consists of bluish quartz and in places contains abundant pyrite and some chalcopyrite. It strikes east and dips steeply south. It occupies a shear zone which cuts and probably displaces slightly the tuff bands, especially at the west end of the vein where the structure swings to the northwest. Along most of the length of the vein the shear is parallel to the tuff bands. This vein is mostly in basic volcanic tuff and lamprophyre dikes and is separated from vein No. 1 by a mass of diorite. In this locality large dikes of porphyry were uncovered during construction of the road to the Aubelle shaft.

There are numerous other veins on the Aubelle property but they are small or only partly uncovered in a few trenches.

Ortona Gold Mines Ltd.

This property is northwest of the Belleterre Quebec mine. Most of the veins are in the southeastern half of the property which is underlain mainly by basic volcanic rocks, diorite, tuff, and probably other sediments.

They are well defined shear veins striking east and dipping steeply south to vertical. The veins are lenticular in shape, and some of them may be followed at the surface for a distance of 800 feet. The widths vary from a few inches to 3 feet. The veins consist of white and smoky quartz which contains in places narrow streaks or pockets of pyrite, chalcopyrite and galena accompanied by a few grains of sphalerite. In some localities the sulphides are disseminated throughout the vein. Gold was found in most of the veins. During 1945 an extensive programme of diamond drilling was undertaken to explore the veins at depth.

Granitic intrusions were observed in the northwestern part of the property.

Flobec Gold Mines Ltd.

This group of 3 claims lies along the southern boundary of the Belleterre property, just north of Guillet (Mud) lake. The whole property is underlain by pillow lava, containing some diorite, porphyry, and lamprophyre dikes. Numerous east-west shear zones contain quartz stringers and some mineralization from which, in places, good gold assays have been reported. Along the northern border of the property a quartz vein of small dimensions, apparently associated with a porphyry dike, has been opened up by several trenches. The shear zones and the vein were explored by diamond drilling.

Brenmore Quebec Mines Ltd.

This property lies north and south of Guillet (Mud) lake and includes the greater part of the lake. It is underlain by lava, tuff, diorite, and porphyry. It is intersected by several faults, the most important in size being the Mud Lake fault, which has a northeasterly trend and follows the whole length of Guillet (Mud) lake.

Numerous veins and mineralized tuff beds north and south of Guillet (Mud) lake have been uncovered by trenching and explored by diamond drilling. Most of the veins trend northeasterly and are within a short distance from the shore of the lake and from the Mud Lake fault. Some are exposed for lengths of more than 100 feet. The maximum width observed was 8 feet. They consist of white glassy quartz containing some sulphides. Most of the mineralized tuff bands are dark and, in places, are accompanied by porphyry. Visible gold is reported to have been found in some of the veins. The gold found was mostly within 500 feet of the north shore of Guillet (Mud) lake. Some of the assays were fairly high.

Manterre Gold Mines Ltd.

This property comprises 5 claims situated a short distance northwest of the Belleterre Quebec shaft No. 3. It is underlain mostly by basic to intermediate volcanic rocks and diorite, cut by dikes of porphyry, lamprophyre and diabase. One quartz vein two feet wide is visible in the southeastern corner of claim R.30910. Most of the drilling done on the property was aimed at intersecting the extension of the Belleterre No.12 vein or veins belonging to the same structure-pattern. Some intersections contained quartz and sulphides, but no gold was found.

Paquin Gold Mines Ltd.

The Paquin property consists of a group of several claims in the central part of the area and one claim (R.43185) northeast of the Conway veins.

In the southwestern group there are a few small veins exposed at the surface, but none of them seem to be of economic importance.

In the northern claim there is one vein, made up of a group of overlapping veins, closely related to a southeasterly trending band of silicified tuff. This vein has been opened up for a length of 1,000 feet over widths of 1 to 6 feet. It consists of white and bluish quartz containing small amounts of pyrite, chalcopyrite, galena and sphalerite. From its west end the vein follows an easterly trending shear zone for a distance of 650 feet, where it fades out. A second vein starts a few feet to the north and extends eastward for 180 feet where it, in turn, pinches out. At this point another vein starts 16 feet to the north and continues easterly for 70 feet where it intersects a southeast-striking tuff band and curves to the southeast for a distance of 25 to 30 feet and again continues towards the east. This vein intersects basic volcanic rocks, diorite and tuffs, and is accompanied by a lamprophyre dike. Good values in gold have been reported from this Paquin vein.

Blondor Quebec Mines Ltd.

This property is in the western part of the area, for the most part in Blondeau township.

Vein No. 1 on this property is one of the first gold-bearing veins discovered in the Belleterre area. It is located north of the Ville-Marie-Belleterre highway at the southwest end of Taché lake. It is an irregular, drag-folded vein that follows a narrow shear zone and a series of tuff bands. The general strike of the vein is a little south of west, and the dip varies from vertical to 60° south. The vein was followed for 250 feet. Its average width is 2 to 3 feet, except where it joins the tuff bed at its western end. At this place there is a series of quartz veins interlayered with the tuff over a width of 10 to 25 feet. A granite porphyry dike follows the bedding in the tuff, and both the dike and the vein are cut off by a fault striking N.60°W.

The vein filling is glassy quartz, banded in places and containing some pyrite, a little chalcopyrite, and some magnetite, especially in the tuff band section. High gold assays and some visible gold have been reported from this vein.

Vein No. 2 is a small vein which crosses the Guillet Gold Mines road about 400 feet south of the Ville-Marie-Belleterre highway.

It is a few inches to 2 feet wide and has been traced for about 100 feet. It strikes approximately east and dips steeply south. The vein is smoky quartz in a narrow shear in the greenstone. A little pyrite and a few grains of chalcopyrite are visible in places.

Vein No. 3 is about 400 feet north of the Ville-Marie-Belleterre highway, and its east end is 600 feet west of Taché lake. The vein strikes east and dips steeply to the south, following the general trend of the regional structure for most of its length. It occupies a narrow shear zone in the basic volcanic rocks. It was traced for a distance of 800 feet. Its width is 1 to 2 feet, except at a few places where it swells to form short lenses of greater width. At the west end of the vein the formations make a sharp bend to the north. At this point the vein splits into several bands having a total width of 15 to 20 feet. These branch veins swing north along with the structure. They have not been explored to their northern end. From this northward bend in the vein there is another branch of vein No. 3 which continues westward along a narrow shear. This vein, which is only a few inches wide, has been uncovered for a short distance only. Vein No. 3 consists of glassy, white and smoky quartz, containing minor amounts of pyrite and pyrrhotite with a few grains of chalcopyrite and sphalerite. Some good assays in gold were obtained from several places in the trenches and in diamond drill intersections. The highest assay reported was 1.55 ounces of gold per ton over a width of 9 inches.

Vein No. 4 is a small vein along a shear zone at the southeast end of Beauclair lake. This vein trends east-west, and has been exposed in one trench only.

Vein No. 5 was exposed in a trench along the south side of the Ville-Marie-Belleterre highway in front of the core shack of Blondor Quebec Mines Ltd. It was covered up at the time of the writer's visit, but it is said to be small and of no importance.

Vein No. 6 is on the north side of the Ville-Marie-Belleterre highway, about 700 feet west of the Blondor Quebec core shack. It is a quartz vein about one foot wide striking east and dipping 40° south. This vein is visible over a few feet only. It appears to occupy a tension crack in diorite. Good assays in gold were reported from this vein.

Veins No. 7 and No. 8 are white quartz veins in greenstone and diorite in the northern part of the property near the granite contact.

Vein No. 9 lies along the southwest shore of Beauclair lake. It is a quartz vein about 1 foot wide striking N.25°W. and dipping 75° northeast in a shear zone accompanying a tuff band. Small quantities of pyrite and chalcopyrite are visible in the quartz.

Other small veins or mineralized shear zones are visible elsewhere in the south half of the property, but they are of minor importance.

Guillet Gold Mines Ltd.

The Guillet Gold Mines property is located in the southwest quarter of the area. Most of the property is west of the Guillet-Blondeau township line.

Vein No. 1 is 700 feet west of lake aux Sables. It has been explored by pits and trenches for a distance of 400 feet. Its width varies from a few inches to 3 feet. The vein occupies a shear zone striking N.60°E. in intermediate, basic, banded lava and volcanic breccia. The shear zone has a maximum width of 3 feet and contains, in places, some sulphides. The vein itself is bluish and white quartz with some carbonate and disseminated sulphides.

Vein No. 2 is approximately 250 feet south of the east end of vein No. 1. It occupies a shear zone in the banded brecciated volcanic rocks. It strikes N.75°E. and dips 80° southeast. The shear, which has a maximum width of 7 feet, is quite rusty in places, and contains abundant sulphide mineralization. It was uncovered in trenches over a distance of 250 feet. The greatest width of quartz measured in the shear is 2 1/2 feet. The quartz is of the banded rusty-blue variety, containing some pyrite and chalcopyrite.

Vein No. 3 occupies a small mineralized shear zone in a brecciated tuff band. Its east end is 650 feet west of the west end of vein No. 1. It strikes approximately east and has a vertical dip. It has been opened up by trenches for a length of 750 feet. Its greatest observed width is 2 feet, but it is very lenticular and in places is only a few inches wide. The vein filling is banded smoky quartz generally containing abundant sulphides.

Diamond drilling was done at several places on the property, but it was not possible for the writer to obtain the records of this drilling.

Girard Lake Mines Ltd.

This property is at the west end of the area. Numerous trenches and a few diamond drill holes represent the exploratory work done on the property. Very few veins are visible and they are all small.

REFERENCES

(1) Wilson, M.E., Témiscamingue County, Quebec, Geol. Surv. Can., Mem. 103.

(2) Retty, J.A., Gaboury-Blondeau Townships Map-Area, Témiscamingue County; Que. Bur. Mines, Ann. Rept. 1930, pt. B, pp. 53-88.

(3) Retty, J.A., Travers Lake Map-Area, Témiscamingue County; Que. Bur. Mines, Ann. Rept. 1934, Pt. C, pp. 19-34.

(4) Henderson, J.F., Guillet (Mud) Lake Area, Témiscamingue County, Quebec; Geol. Surv. Can., Paper 36-11.

(5) Henderson, J.F., Geology and Mineral Deposits of Ville-Marie and Guillet (Mud) Lake Map-areas, Quebec; Geol. Surv. Can., Mem. 201.

(6) Denis, B.T., Guillet Township, Témiscamingue County; Que. Bur. Mines,Ann. Rept. 1935, Pt. B, pp.59-79.

(7) Denis, B.T., Simard (Expanse) Lake Map-Area, Témiscamingue County; Que. Bur. Mines, Ann. Rept. 1936, Pt. B, pp.3-22, 71-74.

(8) Trenholme, L.S., Belleterre Mine; Structural Geology of Canadian Ore Deposits, Can. Inst. Min. and Met. Jubilee volume,pp.796-803.

(9) Auger, P.E., Belleterre Map-Area (Sheet No. 1), Guillet Township, Témiscamingue County; Que. Dept. Mines, P.R. No.194.

(10) Auger, P.E., Belleterre Map-area (Sheet No. 2), Guillet Township, Témiscamingue County; Que. Dept. Mines, P.R. No.203.

(11) Auger, P.E., Belleterre Map-area (Sheet No. 3), Blondeau Township, Témiscamingue County; Que. Dept. Mines, P.R. No.209.

(12) Auger, P.E., Belleterre Area (Sheet No. 4), Guillet Township; Que. Dept. Mines, P.R. No. 245.

(13) Bishop, E.G., Personal communication.

ALPHABETICAL INDEX