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COLLET - LABERGE AREA, ABITIBI-WEST COUNTY

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Énergie et Ressources naturelles
Québec

PROVINCE OF QUEBEC, CANADA

DEPARTMENT OF NATURAL RESOURCES

RENÉ LÉVESQUE, Minister P.-E. AUGER, Deputy Minister

GEOLOGICAL EXPLORATION SERVICE

H.W. McGerrigle, Chief

GEOLOGICAL REPORT 116

COLLET-LABERGE AREA

ABITIBI-WEST COUNTY

by

Raymond Davies

QUEBEC

1964

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COLLET-LABERGE AREA

Abitibi-West County

by
Raymond Davies

INTRODUCTION

General Statement

In recent years considerable interest has been evinced by mining companies and prospectors in the Abitibi and northern greenstone belts. In the Collet-Laberge area, mapped by the writer during the summer of 1961, interest has centred on a broad belt of Precambrian volcanic and minor sedimentary rocks that underlies about half the area. The volcanics are cut by granites and related rocks. Much staking has been done, especially along contact zones. Diabase dykes are the youngest intrusives. Traces of sulphides in the relatively few exposures of volcanic rocks indicate economic possibilities for the area.

Location

The area is bounded by latitudes 49°15' and 49°30' and by longitude 79°00' on the east and the Quebec-Ontario boundary (about longitude 79°31') on the west. It comprises approximately 405 square miles in Abitibi-West county, including all of Collet and Laberge townships and portions of Boivin, Paradis, Lemaire, Brabazon, Estrées, Casa-Berardi, and Dieppe townships. The central part of the area is about 75 miles north of the cities of Rouyn and Noranda.

Access

The southern boundary of the area is 31 miles to the north of La Sarre, a town on the Quebec-Cochrane line of Canadian National Railways. From La Sarre good roads go as far north as Val-Paradis (St-Ephrem-de-Paradis), about 5 miles south of the area, from where winter roads used by the lumber companies serve the southern half of the area. A Bombardier snowmobile was found to be the most reliable and economical means of transport on the bush roads under varying conditions. A fairly well-kept road between Audet sawmill at Val-Paradis and the Audet lumber camp is suited to farm tractors and, in dry weather, to four-wheel-drive vehicles. This road is being extended, for winter use only, well into the north.

Turgeon river affords access by canoe to the west and northwest parts of the area. From Val-Paradis, via Boivin river, little difficulty was experienced in reaching the confluence of Turgeon and Burntbush rivers just outside the northwest corner, in spite of a fairly dry summer. Only five portages were necessary, the longest being about 1,000 feet. All are in good condition. Orfroy creek, a tributary of the Turgeon, and Ménard river in the southeast, a tributary of the Wawagosic, are suitable for canoes only during periods of heavy rainfall, owing to many windfalls and small boulder rapids.

The least accessible northern and northeastern portions were covered with the use of a helicopter. However, the northeast corner may be reached by canoe from Wawagosic river.

There are no lakes accessible to float-planes.

Surveyed township lines are largely overgrown but can be followed in most cases. The Quebec-Ontario boundary line is easily followed.

Field Work

The field work was carried out from the beginning of June to mid-September.

The base-map, at a scale of 2 inches = 1 mile, was compiled by Photo Air Laurentides from aerial photographs at the same scale. Other aerial photographs at 1 inch = 1 mile were obtained from the R.C.A.F.

Outcrops are fairly plentiful in the south, occurring mainly on low hills and along lumber roads, although some are found along streams such as Turgeon and Ménard rivers. All navigable streams were examined for exposures and special attention was paid to lumber roads. The intervening ground was covered by pace-and-compass traverses, spaced generally at 1/2-mile intervals. However, in the central and northern parts of the area, where outcrops are sparse, traverses were more widely spaced but planned to cover the ground that appeared, from a study of aerial photographs, to be more favourable for exposures. The least promising sections were flown by helicopter and a careful search made. In general, most outcrops could be spotted on aerial photos prior to traversing.

Acknowledgments

F.P. Naugler of McGill University acted as senior assistant, and J.P. Bilodeau and Y.L. Pagé, both of Université Laval, as junior assistants. L.P. Arsenault, E. Fortin and B. Gagnon served as canoemen, and J. Fortin was cook. Several members of J.H. Remick's party assisted towards the close of the season. All these men performed their respective duties in a highly satisfactory manner.

The writer is indebted to J.H. Remick of the Geological Exploration Service for his advice and cooperation throughout the field season. Special thanks are also due to Quebec Lands and Forests Department, La Sarre, and to Audet Frères Enr., Val-Paradis, who allowed the party to use their camps within the area.

Discussions with several staff members and graduate students of McGill University were of considerable value during the preparation of this report.

Previous Work

T.L. Tanton (1919) mapped the Harricana-Turgeon basin, of which the Collet-Laberge area is a part, at 4 miles = 1 inch. R. Thomson (1937) made a reconnaissance geological survey of the Burntbush River area adjacent to the west in Ontario. The Perron-Rousseau area to the south was mapped at 1 mile = 1 inch by G.F. Flaherty (1939), and the Mistawak Lake area to the east and southeast at 2 miles = 1 inch by J.T. Wilson (1938,1940). The Harricana-Turgeon area to the north and northeast was mapped by J.H. Remick (1964) at 1 mile = 1 inch.

DESCRIPTION OF THE AREA

Settlement and Resources

Inhabitants

The area itself has no permanent inhabitants. However, the nearest settlement, Val-Paradis, lies only a few miles to the south.

Agriculture

In general, the southern portion of the area is suitable for agriculture as it is fairly well drained and much of the soil mantle is clay. Considerable areas of coarse sandy material and a fair amount of outcrop do, however, occur. The short growing season is a limiting factor. Owing to poor drainage, most of the northern portion is unsuitable.

Timber

Lumbering is the only important industry. The southern part of the area is fairly heavily wooded, although a considerable amount of this timber has been cut. Towards the swampy northern part, the better stands occur in isolated patches on higher ground. Areas of old burn are evident in the north and east.

Black and white spruce are the most common trees. Locally, balsam fir, balsam poplar, trembling poplar, white birch, tamarack, and occasionally cedar occur. Jack-pine is abundant in sandy regions, and alders predominate along the banks of all streams.

Fish and Game

Moose are plentiful, especially along Turgeon river, and black bear are common. Fresh wolf tracks were seen occasionally. Beaver colonies are widespread. Mink, weasel, and woodchuck were also seen. Squirrels are common.

Fishing is generally poor. However, trout were caught in several of the creeks, and pike in rapids of Turgeon river.

Weather

Two days of light snow were experienced at the outset of the 1961 season, after which the weather settled into a pattern of overcast days interspersed with a number of fine periods, and relatively few periods of heavy rain. Most precipitation was in the form of light showers. Heaviest rainfall occurred during July which was also a month of considerable fine weather. It was noticed that in each case during that time precipitation was preceded by several hot, windy days.

As far as temperature is concerned, there was a trend from cool to warm in June, becoming hot for the greater part of July. August and September showed a downward trend but there were isolated hot days. Frost was experienced at the close of the season in mid-September.

Physiography

Topography

The land surface is generally flat. However, in the southeastern portion of the area rounded hills of granite rise a few hundred feet above the surrounding country (Plate I-A). The southern part of the area offers the greatest exposure of outcrop. It is thickly wooded, with relatively small areas of swamp. Towards the north, swamps increase in number and size, covering up to 60 per cent of the surface in the northeast (Plate I-B). In the northwest corner massive lavas form a number of prominent hills. A southwest-trending diabase dyke has given rise to an intermittent resistant ridge across the southeast corner of Laberge township. The dyke continues into the northwest corner of Paradis township where it is not as marked. The lavas in the southern half of Laberge township form only small ridges.

Trending about N.30°W. across Paradis and Laberge townships is a prominent esker-like ridge partly buried by a glacial outwash deposit. The latter is marked by a line of small kettle lakes. Other glacial features are kames and sand and gravel ridges trending N.30°W.

Drainage

Drainage is by way of Turgeon river and its tributaries, via the Harricana northward into James bay. The four major tributaries - Orfroy creek and Corset, Théo, and Ménard rivers - rise along the northwest-trending outwash deposit. The latter forms a divide between Ménard and Théo rivers in the east, and Orfroy creek and Corset river in the west.

The overall drainage pattern is dendritic. The rivers in the southern part of the area occupy valleys that are somewhat deeper than the stream courses in the north. Orfroy creek and Turgeon and Ménard rivers have, in places, cut through the glacial overburden to expose bedrock surfaces on which glacial striae are often well preserved (Plate VII-A); in other places boulder deposits interrupt the streams. Slumping along river banks was observed at a number of places (Plate II-A). High-water levels during spring floods are marked by ice scars on river banks and debris above the normal water level (Plate II-B).

Lakes in the area are few and very small, never more than a mile long. Apart from the kettle lakes, a number of small ones enclosed by extensive swamps are scattered over the northern half of the area (Plate I-B).

With the disappearance of the Pleistocene ice-sheet the drainage system that developed was greatly influenced by glacial deposits. Eskers and sand ridges formed divides between streams. Depressions gave rise to lakes and swamps.

GENERAL GEOLOGY

General Statement

The Collet-Laberge area straddles the contact between intrusive rocks, referred to as the "Mistawak Batholith" by Tanton (1919, p. 42), and a volcanic-sedimentary sequence to the north. The latter is part of a broad belt extending from the Quebec-Ontario border over 200 miles eastwards to Lake Chibougamau.

All the consolidated rocks are considered Precambrian in age, though diabase dykes and other small intrusives may be younger. Roughly half the area is underlain by granites and related rocks. Four distinct types are recognized. They underlie most of the southern quarter and eastern third of the area; small outcrops also occur on Turgeon river in the west. The north, northwest, and central parts are underlain by metamorphosed volcanic and sedimentary rocks. A southwest-trending diabase dyke is exposed intermittently in the southeast quarter of Laberge and the northwest part of Paradis townships.

Unconsolidated gravels, sand, silt, and clay of Pleistocene and Recent ages are widespread.

Contacts were rarely seen, and most of the geological boundaries shown on the accompanying map are assumed.

Table of Formations

Pleistocene and Recent	Boulders, gravel, sand, silt and clay
	Unconformity
Precambrian	Diabase and lamprophyre
	Pegmatites, aplites, granophyres Granitic gneisses and granite : medium-grained grey granitic gneiss and granite; medium-grained pink granitic gneiss and granite; coarse-grained pink granite
	Diorite complex: gneissic quartz-diorite, diorite, leucogabbro, anorthositic gabbro, gabbro
	Metasedimentary rocks: mica schist; hornblende schist; epidote schist; hornblende-chlorite-muscovite rock; quartz-feldspar-sericite schist; impure quartzites Inclusions in the diorite complex Amphibolites Metavolcanic rocks : intermediate and basic volcanics; acidic volcanics; volcanic agglomerate

Metamorphosed Volcanic and Sedimentary Rocks

Intermediate and Basic Volcanics

Intermediate and basic volcanics are the predominant and most widespread rocks of the volcanic-sedimentary group observed on outcrops. All have been metamorphosed to some degree, but generally the grade of metamorphism has been sufficiently low for the preservation of structural features that clearly indicate their volcanic origin. Towards granite contacts the grade of metamorphism increases and the rocks have been converted to amphibolites.

For convenience the rocks will be described according to their geographical location and grade of metamorphism.

Intermediate and basic volcanics of the north and northwest

Outcrops along the northern boundary of the area are mainly massive, fine-grained, greyish green rocks. The mafic constituents have generally been altered to chlorite, though some outcrops show, in hand specimens, dark green hornblende crystals 1/8 to 1/4 inch long in a fine, chloritized groundmass. Schistose varieties occur to the east. A mauve-coloured variety, apparently interlayered with the greyish green type, is exposed in a limited area. It occasionally exhibits pillow structure. In places greenish grey chert occurs as much deformed bands or lenses in the lava. Epidote is abundant in some outcrops, and calcite and quartz veins are fairly widespread.

The weathered surface of the massive lavas is rusty-brown and fairly smooth, the weathered layer being 1/4 inch thick. In the schistose varieties the surface is a little rough and a paler brown, and weathering is deeper.

Microscopically, the rocks are composed essentially of feldspar and chlorite, with or without hornblende. The proportions of these minerals are extremely variable and difficult to determine accurately. Chlorite and hornblende together amount to 40-60%, and the feldspar 30-40% of the rock. As much as 15% quartz is often present, as well as small amounts of carbonate, epidote, magnetite, pyrite, and sphene.

The feldspar is cloudy, being extensively broken down to saussurite masses, epidote, carbonate, albite, and sericite. Twinning is evident in less altered specimens, and in two cases the composition was determined to be albite (An_{2-4}).

Hornblende is green and occurs as small shreds or tabular crystals. Chlorite was observed in all sections as an alteration product of the ferromagnesian minerals. Quartz occurs in small veinlets and scattered throughout the groundmass. Calcite, formed by the breakdown of plagioclase and ferromagnesian minerals, occurs, like quartz, both in veins and in the groundmass. Epidote is present as distinct grains and in saussurite masses. Commonly associated with the ferromagnesian minerals are magnetite and pyrite, the former being sometimes surrounded by a corona of sphene.

The mauve variety consists of fine interlocking needles of altered feldspar with dark interstitial material. Flow structure is shown by the imperfect alignment of the needles.

Audet camp and Le Roux road

A number of small outcrops of basic schists are found in the neighbourhood of Audet camp and Le Roux road. They are best exposed on lumber roads where they have been stripped of moss and soil cover, revealing smooth glaciated surfaces. Though the rocks have been metamorphosed and are highly deformed, structures of volcanic origin are well preserved and are especially visible on the weathered surface which is generally grey to dark greenish black.

Pillow structures 1 foot to 3 feet in diameter are a conspicuous feature. They have a dark, fine-grained rim enclosing a coarser-grained and lighter-coloured interior (Plate IV-A). Amygdules around the edges of the pillows are elongated in the direction of the schistosity.

Smaller pillows, up to 1 foot in diameter, occur on an outcrop about half a mile south of Audet camp. A rusty-weathering material is found between many of the pillows.

On the same outcrop is a lava flow, 1 foot thick, lying between beds of what appears on the weathered surface to be volcanic agglomerate (Plate III-B). The lava is amygdaloidal on the northern side and along the southern contact contains a few inclusions around which flow structure is visible. This indicates that the flow top is to the north. As the flow dips to the south, the beds would here be overturned.

The rocks in this central part of the map-area are predominantly fine grained and schistose, though interbedded on the most southerly of this group of outcrops are coarse-grained varieties. These rocks consist essentially of hornblende, but several outcrops near Le Roux road are highly chloritic, similar to the volcanics in the north and northwest. They are often amygdaloidal though highly sheared.

Microscopically, the predominant variety consists essentially of 75-80% hornblende, 10-15% epidote, small percentages of chlorite, feldspar, and quartz, and minor amounts of magnetite and sphene.

The hornblende crystals are anhedral to subhedral and show pleochroism from dark green to light greenish brown. The hornblende alters to chlorite. In hand specimens, hornblende needles often show pronounced lineation.

Feldspar is usually too fine grained and altered to determine its composition. Comparison of refractive indices with balsam suggests that it is oligoclase-andesine. However, there are lighter-coloured lavas that have hornblende and plagioclase in equal proportion. These rocks permitted the determination of the plagioclase composition which was oligoclase (An_{28-30}).

A thin section of one of the small pillows visible on the outcrop immediately south of Audet camp showed it to be composed of a core consisting of 30% hornblende, 50-60% plagioclase (An_{38}), 10-15% pyroxene, and 10% epidote, surrounded by a highly altered rim extremely rich in epidote with a little carbonate, magnetite and sphene.

The rusty-weathering material between many of the pillows consists in thin section of a medium- to fine-grained mass of pale green pyroxene, pink garnet, epidote, and dark green hornblende, the proportions of each mineral varying considerably. Magnetite and limonite are also present.

The volcanic agglomerate in thin section consists predominantly of hornblende, pyroxene and epidote, with minor amounts of chlorite, magnetite and sphene. The three main constituents vary in proportion in different parts of the slide. There is also considerable variation in grain size, from medium to fine grained.

In the last 3 rock types described, the pyroxene is very pale green and slightly pleochroic. It occurs in anhedral grains showing little alteration. $2Vz = \pm 58^{\circ}$ and $C \wedge Z = 44\text{-}46^{\circ}$. According to Winchell (1959, pp. 408-410) this would be ferroaugite or ferrosalite. Hornblende sometimes appears to be replacing pyroxene. The hornblende is anhedral to subhedral. Pleochroism is from green or bluish green to greenish brown.

The garnet is pink. It has a refractive index of 1.7870 ± 0.0005. It was also seen in hand specimens in and around vesicles in the pillow lavas.

Amphibolites

Dark greenish black amphibolites occur at a number of places, but they are not differentiated from the metavolcanics on the accompanying map. They are well exposed on Turgeon river in contact with biotite granite, close to the granite contact near Le Roux road, and as inclusions and roof pendants in the pink gneissic granite in the southeast corner of the area.

The rock is generally fine grained and has a marked schistosity and lineation owing to the alignment of hornblende crystals. Interlayers of medium- to coarse-grained varieties are not uncommon; where these occur there is usually a gradation from one type to the other.

The Turgeon River occurrence is the best exposure. Here the amphibolite has been fractured into large angular blocks between which the granite has intruded. These blocks are of the order of 100 feet or more across, though smaller inclusions in the granite are also seen (Plate VI-A). All the blocks are cut to some extent by granite and pegmatite dykes or veins. Where the amphibolite was weakest the granite forced itself along intersecting cleavage planes to such a degree that it constitutes half the rock (Plate V-B). These strongly intruded amphibolites show signs of plastic deformation or flow. Originally elongated angular fragments have been folded and small ptygmatic veins of granite cutting the amphibolite are common. Sharp corners normal to the intruding granite have been rounded, whereas those parallel to the intruding granite taper off into points. Contacts with the granite are sharp (Plates V-A and V-B). Occasional small rounded inclusions and patches of slightly darker, more gneissic material in the granite were probably originally acidic in composition, and thus more readily absorbed.

In the pink gneissic granites of the southeast corner of the area the amphibolite occurs as inclusions from several feet across up to large masses a mile long. The latter are shown on the map. They probably represent remnants or roof pendants of what was a continuous greenstone belt connecting the southeast projecting nose of the Collet-Laberge greenstones and a northwest projecting nose of the greenstones to the southeast in the Mistawak Lake area (Wilson, 1938). The amphibolites are cut by veins and dykes of pink granite which tend to follow the schistosity and vary from a fraction of an inch to several feet in width. As on Turgeon river, contacts with the granite are sharp.

Paper-thin banding, owing to metamorphic differentiation of the hornblende and light-coloured minerals into separate sheets, is common. Where there has been later injection of quartz and feldspar, the bands of alternating dark and light material are up to 1/2 inch wide. There is also compositional layering on a slightly larger scale. This is best seen on the weathered surface.

The weathered surface is rough, owing to differential weathering, with bands rich in quartz, feldspar, and epidote being the most resistant. It is normally greenish black, but is grey where rich in feldspar. Epidote bands are light green. Sulphides, where present, give the surface a rusty brown appearance. Many of the feldspar-rich bands are light coloured and powdery to a depth of 1 inch to 2 inches.

The amphibolites consist mainly of hornblende and feldspar; the content of the former is 45-70% and that of feldspar 25-50%. As much as 5% quartz is often present. Epidote varies from 0-5% and minor amounts of biotite, sphene, magnetite, pyrite, apatite, chlorite and sericite are common.

The hornblende is dark coloured, pleochroic from blue-green to greenish brown, and forms crystals up to 1/2 inch long. In the finer-grained varieties the crystals are generally euhedral to subhedral, whereas in the coarser varieties they are anhedral. Inclusions of feldspar and magnetite are common, giving a sieve texture to the crystals.

The feldspar is twinned and occurs as anhedral to subhedral grains interstitial to the hornblende. On Turgeon river the feldspar is highly altered and the composition could not be determined. In the south-east, however, it is fresh and the composition varied from andesine (An_{35}) to labradorite (An_{54}).

The biotite is brown and has grown at the expense of the hornblende. Flakes were seen growing perpendicular to the schistosity. Chlorite is an alteration after hornblende, and sericite and epidote have formed at the expense of plagioclase. Sphene occurs as coronas around magnetite.

<u>Inclusions in the Diorite Complex</u>

Scattered throughout the diorite complex are inclusions of intermediate to basic material similar in composition to the amphibolites. They are particularly abundant west of Turgeon river, along the southern boundary of the area in Paradis township, and on Le Roux road near the greenstone contact.

These rocks are fine to coarse grained. Though schistosity is not pronounced, in thin section the finer-grained varieties show a preferred orientation of hornblende. The coarse-grained varieties are generally more massive.

The size of the inclusions ranges from a few feet across to several hundreds of feet. All observed contacts showed the granitic material cutting the basic material. Though the contacts are sharp, many finer-grained varieties show an increase in grain size along the boundary zone.

Petrologically, the rocks will be described under two headings : fine-grained and coarse-grained varieties. These are the dominant types but gradations occur between the two.

a) Fine-grained variety:

The composition is essentially 50-65% feldspar and 30-50% hornblende, in places with up to 15% quartz. Minor amounts of apatite, magnetite, and sphene are common. Altered types contain 0-3% biotite, 5-10% chlorite after hornblende, and 0-15% epidote and a little muscovite after feldspar.

b) Coarse-grained variety:

These rocks differ from the fine-grained type in the relative proportions of hornblende and feldspar. Feldspar varies between 5-25%; hornblende, between 50-95%; and quartz, between 1-25%. Alteration of the hornblende produced chlorite, whereas the feldspar gave rise to sericite, epidote, and albite. Minor amounts of apatite, magnetite, and pyrite are also present.

Feldspar of both varieties is andesine (An_{30-47}), in well twinned anhedral grains in many places slightly altered to sericite or saussurite. Hornblende is pleochroic from blue-green to greenish brown. The bluish colour, however, is not as marked in the coarse-grained variety. The grains are anhedral to subhedral. Zoning is conspicuous in the coarse-grained variety, where the cores of crystals are usually lighter in colour. Quartz, which is usually blue in hand specimens, is clear in thin section.

<u>Acidic Volcanics</u>

Although acidic volcanics were not observed within the map-area, they do occur about 1 mile west of mile-post 131 of the Quebec-Ontario boundary, along rapids on Turgeon river just above its confluence with Burntbush river. They have been described by Tanton (1919, p. 24). Thomson (1937, P. 55) described similar acidic volcanics farther west on Burntbush river. As the Ontario exposures strike easterly the formation may well continue across the border into Dieppe township; therefore, they are mentioned here.

Volcanic Agglomerate

Also in Ontario, on a small island in Turgeon river just above its confluence with Burntbush river, is a volcanic agglomerate mentioned by Tanton (1919, p. 24). Angular to rounded fragments of acidic lava are enclosed by a blue-green, partly vesicular, intermediate or basic lava (Plate III-A). The latter consists of phenocrysts of feldspar (An_{2-4}) 1-2 mm. long in a fine-grained groundmass still showing decussate structure. The groundmass consists of feldspar, chlorite, and sericite. Chlorite occurs as alteration after feldspar, and also in larger masses sometimes associated with magnetite, probably pseudomorphous after ferromagnesian minerals. Sericite occurs as an alteration product in the feldspar phenocrysts, but more abundantly as fine flakes in the groundmass. Carbonate veins cut the rock. Carbonate also occurs as disseminated grains in the groundmass, and as an alteration in feldspar phenocrysts. Quartz occurs with carbonate in veins and fills vesicles.

Somewhat similar-looking volcanic agglomerate (Plate III-B) occurs on an exposure about half a mile south of Audet camp. It was mentioned previously in that section of the report dealing with the metavolcanic rocks.

Metasedimentary Rocks

Rocks of probable sedimentary origin are limited in distribution. They appear to be interbedded with the volcanics, though contacts were rarely observed. All have been metamorphosed, and they are now represented mainly by various types of schists.

Mica schists in the southeast

These rocks are exposed in the southeast nose of the volcanic-sedimentary sequence projecting east of Le Roux road. They are dark grey, fine-grained, finely-banded schists, showing small drag-folds in many places. The weathered surfaçe is light brown with very fine banding of dark and light material.

In thin section the rock is composed essentially of 30-35% feldspar, 45-50% quartz, and 10-15% mica. Both muscovite and brown biotite are present but one is usually predominant. Varieties rich in biotite contain up to 10% epidote and a little chlorite. Minor amounts of magnetite, pyrite, sphene, and apatite are also present. The composition of the feldspar was determined as An_{3-5}. Scattered through the muscovite-rich variety are rounded to subangular, porphyroblastic grains of feldspar and quartz up to 1 mm. in diameter.

Plate I

A. – View of prominent hill in southeast corner on which boulder beaches occur.

B. – Typical swampy lake in northern part of area.

Plate II

A. – Slumping along banks of Turgeon river.

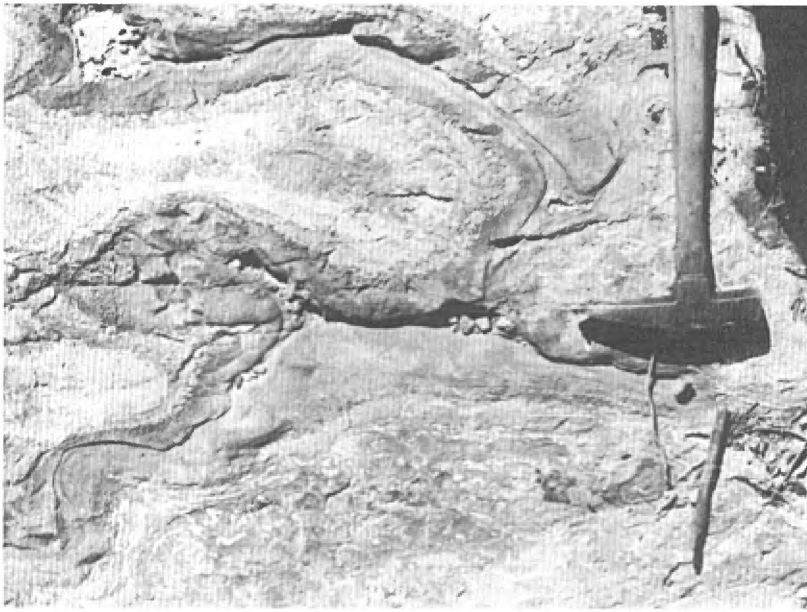
B. – Ice scar on island in Turgeon river, northwest corner of area. View looking downstream.

Plate III

A. — Volcanic agglomerate on Turgeon river above confluence with Burntbush river, Ontario. Acidic material light; basic material dark coloured.

B. — Bedding in metamorphosed volcanics, Audet camp. Width of light-coloured band is 1 foot.

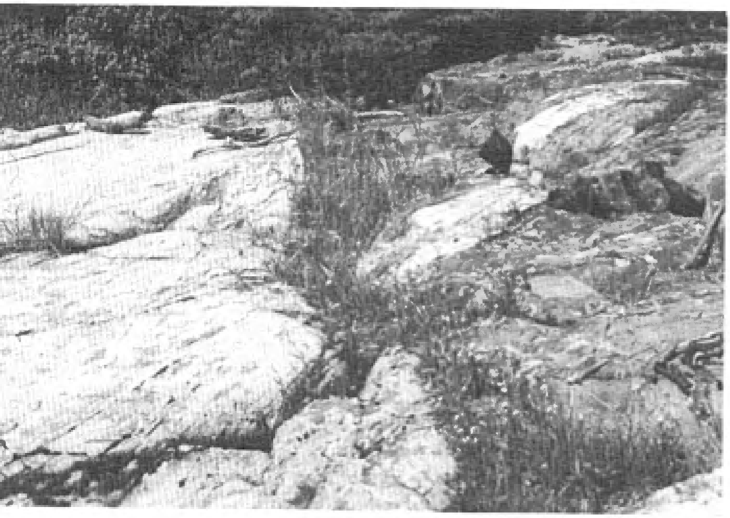
Plate IV



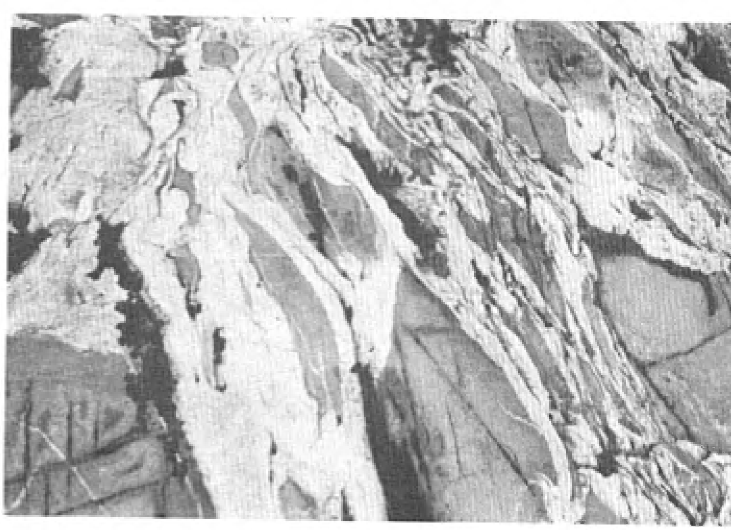
A. — Pillow lavas, Audet Camp.

B. — Inclusion of hornblende schist in diorite; both cut by pink granite pegmatite.

Plate V

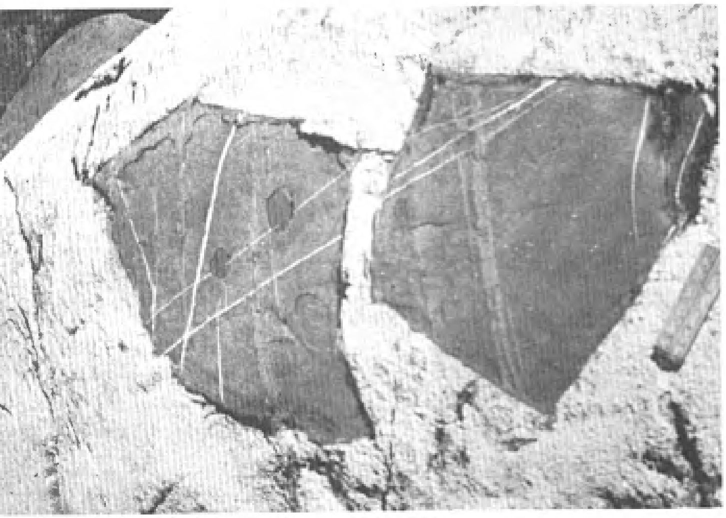


A. – Contact between biotite granite and hornblende schist, Turgeon river.

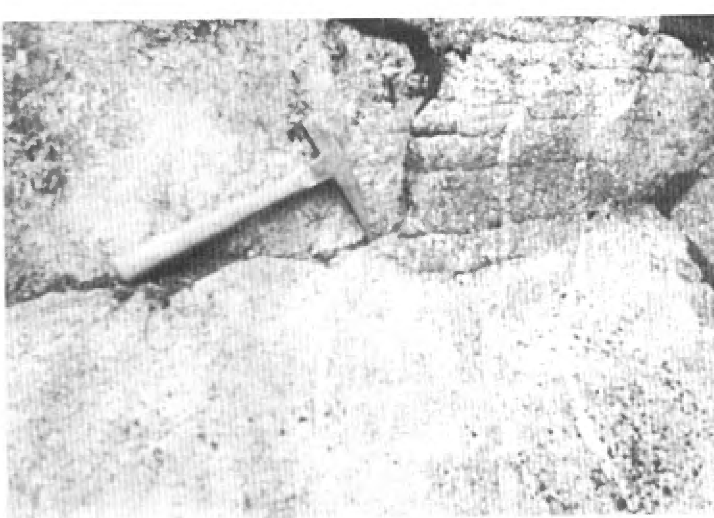


B. – Amphibolite intruded by grey biotite granite. Width of photo approximately 8 feet.

Plate VI



A. — Inclusions of amphibolite in biotite granite, Turgeon river.



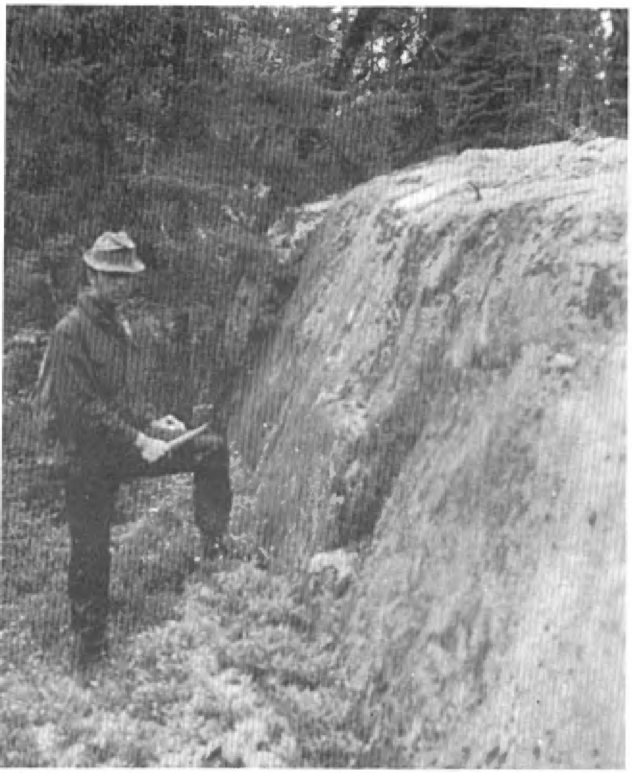
B. — Almost completely replaced inclusion in diorite.

Plate VII

A. – Glaciated bedrock uncovered in Turgeon river.

B. – Erratic boulder of biotite granite on edge of swamp. Near Le Roux road in southern part of area.

Plate VIII



A. — Typical joint surface on southern side of outcrop in the diorite complex.

B. — Well-jointed biotite granite, Turgeon river.

Schists on Turgeon river in the west

On Turgeon river, 1 mile above No. 2 rapids, is a poor exposure intruded by granite. Several different rock types occur in close proximity, but their relationships to one another are obscure.

Hornblende schist – The rock is greenish grey but otherwise similar in appearance to the mica schists of the southeastern part of the area. It is fine grained and schistose with a marked alignment of the hornblende crystals. A thin section consisted of 45-55% feldspar, 20-30% quartz, and 20-25% hornblende, with 2-3% biotite and minor amounts of muscovite, chlorite, and leucoxene. Many of the feldspar grains are cloudy owing to alteration to sericite. However, other grains are fresh and show good twinning. The composition of the feldspar is An_{34-36}. Hornblende is the green variety with pleochroism from blue-green to greenish yellow.

Epidote schist – This rock is pale greenish brown and fine grained. The composition in thin section is 60-70% feldspar, 20-25% quartz, and 10-15% epidote, with minor amounts of chlorite, leucoxene, and carbonate. The feldspar is cloudy, usually twinned, and has a composition of An_{2-3}.

Hornblende-chlorite-muscovite rock – The rock is medium to fine grained, fairly massive, and has a silvery green colour. Mineral percentages were difficult to determine. However, it consists roughly of 30-45% chlorite, 30-40% hornblende, 10-15% muscovite, 10% epidote, and 5% feldspar. Hornblende occurs as acicular crystals; it is pleochroic from blue-green to greenish yellow. Hornblende, chlorite, and muscovite occur as an interlocking mass in which lie clusters of epidote grains. The feldspar occurs in the groundmass in minute grains.

Schists in the north and northwest

A quartz-feldspar-sericite schist is interlayered with the acidic lavas on Turgeon river, across the border in Ontario. An exposure of similar schist occurs in the south of Casa-Berardi township. This rock is greenish grey, highly sheared, and extremely rough weathering. Fresh surfaces have a nodular appearance owing to resistant grains of quartz and pyrite.

A thin section consists of 15-25% quartz and 5% pyrite as angular grains in a fine-grained schistose groundmass of sericite, chlorite, feldspar, and quartz, totalling together 45-65%, and carbonate 15%.

Quartz grains are 1-2 mm. in diameter, whereas the pyrite grains are much larger, often about 1 cm. in hand specimens. Shearing has fractured both quartz and pyrite grains, especially the latter. Long stringers of pyrite fragments are stretched out parallel to the schistosity in many places. Growth of feldspar normal to schistosity is common on sides of pyrite grains.

Impure quartzites northeast of Audet camp and southeast of Le Roux camp

A small outcrop 2 1/2 miles northeast of Audet camp consists of impure micaceous quartzite and feldspathic quartzite. The rock is dark grey to greenish grey. Quartz grains 1/2 cm. in diameter are visible in hand specimens. Pyrite cubes and limonite are present in many places.

Microscopically, the rock is of two types - one containing feldspar, the other without feldspar. The latter, which is darker in colour, consists of 70-80% quartz, 10-15% muscovite, 10-15% chlorite, and a little pyrite. The feldspathic variety is composed of 60-70% quartz, 30-40% alkali feldspar, and 5-15% muscovite. Medium-sized, sub-rounded to rounded grains of quartz occur in a finer-grained matrix of quartz, muscovite, and either chlorite or feldspar. Many quartz grains show secondary growth around the edges; this is conspicuous as the secondary quartz is full of small inclusions of muscovite. In the feldspathic varieties feldspar occurs in the groundmass and replacing quartz. It is fine grained and its composition could not be determined. However, its refractive indices are close to that of balsam, which suggests that it is albite. Muscovite is concentrated in bands that probably represent bedding; the strike is northwesterly. The orientation of the small flakes, however, is in two directions at 45° to the banding.

Rock of a similar appearence occurs 2 1/2 miles southeast of Le Roux camp, close to the diabase dyke. It is light greenish, medium- to fine-grained, impure quartzite, containing 80-85% quartz, 15% epidote, 2-3% chlorite, and minor amounts of biotite, magnetite and feldspar. The presence of the epidote is probably due to its proximity to the diabase dyke.

The strike of the quartzite is close to east. This direction is roughly at right angles to that of the nearby dioritic rocks, and the quartzite thus appears to be an inclusion in the latter.

Metamorphism of the Volcanic and Sedimentary Rocks

Metamorphism of the volcanic-sedimentary group is typical of the greenstone belts of shield areas. From the north and northwest the grade of regional metamorphism increases southwards to the granite contacts. Contact metamorphism has affected inclusions in the diorite complex and the rocks in immediate contact with the granites.

The minerals of the volcanic and sedimentary rocks of the north and northwest are those typical of the greenschist facies of Turner and Verhoogen (1960, p. 533). The presence of the quartz-albite-epidote assemblage in the basic volcanics is diagnostic. The low grade is also shown by the preservation of original textures in both the volcanic and sedimentary rocks. Probably also in the greenschist facies are the impure quartzites northeast of Audet camp. Although composition of the feldspar was not determined, the mineral assemblage and preserved sedimentary texture suggest a low grade.

Farther south, at or near the granite contacts, the rocks belong to the almandine-amphibolite facies of Turner and Verhoogen (1960, p. 544). The feldspars are oligoclase or more calcic plagioclases, and epidote is abundant.

The inclusions in the diorite complex have similar mineral assemblages to those of the almandine-amphibolite facies, but there is a noticeable lack of epidote except in some altered varieties.

Diorite Complex

The best exposed geological unit in the area includes several kinds of dioritic and gabbroic rocks so disposed that it is not feasible to separate varieties in the field. The term "complex" can be applied to it, and because andesine and hornblende are almost ubiquitous the name "diorite complex" is used, although it must be realized that the name does not imply that the rocks are plutonic.

The rocks crop out mainly in the southern part of the area south of the belt of greenstone; there are also a few exposures in the eastern part of Laberge township about 1 mile south of Le Roux camp, and one on Turgeon river in northwestern Collet township. Within the main area of outcrop, the exposures form rounded hills standing above the overburden.

Much of the complex is layered. The layers are thick in places (for example east of Turgeon river); in some other places they are thin; and finally some layers are like those seen in ordinary gneisses.

Most of the exposures show a medium-grained, white to dark grey gneiss in which hornblende and plagioclase can be seen. Some varieties have bluish quartz which gives a bluish cast to the exposed surface. The weathered surface is commonly rough, with the hornblende standing in relief and giving a greenish tint to the surface.

A score of thin sections cut from the rocks of the complex show a diversity of texture and mineralogy. Plagioclase occurs in most of the sections and forms from one-half to three-quarters of the rock. It shows an extreme range in composition, viz from An_{20} to An_{80}; in many of the thin sections zoning within individual crystals is in excess of 20 mole per cent anorthite, the cores being more calcic than the rims. Common varieties of the rock contain andesine or sodic labradorite. In most specimens the plagioclase is clear, but in a few it is clouded with alteration products.

The commonest amphibole is a hornblende that is much less absorptive in thin section than that of the hornblende-andesine rocks described in an earlier section of this report. The properties are somewhat variable from section to section, but an absorption in pale olive-green is characteristic. In places this amphibole can be seen to replace plagioclase; in turn, it is seen to be replaced locally by an actinolitic amphibole. Minerals of the epidote group occur but not in great force. An optically positive augite and an optically negative ortho-pyroxene occur sparingly. Both minerals are rimmed by amphibole.

Quartz is irregularly distributed in the rock, as may be seen in even one thin section. In a few places it forms slightly more than one-third of the rock, but some other rocks are devoid of it.

The diversity of the rocks involved in the complex suggests that the formation is not of simple origin. The layering commonly seen, and the occurrence of very basic plagioclase as well as ortho- and clino-pyroxene suggest that the layered complex of anorthosite, anorthositic gabbro and gabbro has been modified, with perhaps some other formations involved.

Editor's Note: It is reasonable to infer that the complex is similar to those known as the Chibougamau and Bell River complexes. The evidence from the thin sections from the present area, together with data from the other layered gabbro complexes, suggests a history as follows. The original magmatic body was intruded as a sheet and differentiated in place to give the layers, which were originally horizontal. The layered complex was folded along with the enclosing rock and the rocks were regionally metamorphosed so that the pyroxenes were converted to hornblende and the calcity of the plagioclase was reduced. At Chibougamau the metamorphism was to a lower grade than at Bell river, and the grade in the present area is comparable to that at Bell river. Subsequently the complex was altered by the injection of an acidic magma. Not only was the magma a source of heat, but it also transfused material into the rock. The blue quartz was introduced at this time.

The foregoing conclusions are of more than academic interest. The layered gabbro complex provides a structural and stratigraphic datum for correlation of Precambrian formations. Moreover, it is suggestive in the search for mineral deposits; ore deposits have been found at Chibougamau, and also close to the Bell River complex. It is worth suggesting that regions near all such complexes merit careful prospecting.

Granitic Gneisses and Granite

Granitic gneisses and granites crop out in the eastern and southeastern parts of the area as well as along Turgeon river, in the western part of the area. Three units were separated in the field and are shown on the geological map. The units are not homogeneous, but the dominant rock seen in the field gives the name for the group. The groups so established are: a) medium-grained grey granitic gneiss and granite, b) medium-grained pink granitic gneiss and granite, and c) medium- to coarse-grained pink granite.

Medium-grained Grey Granitic Gneiss and Granite

These rocks underlie the northeast and east-central parts of the area and occur along Turgeon river in the southwest part of Collet township. The rocks are superficially homogeneous and are medium grained, and white or grey on the fresh surface. The gneissic structure is most obvious in the coarser-grained rocks and those richer in mafic minerals, but, particularly in Brabazon township, the gneissic structure is obscure.

Inclusions are common. Inclusions of the metalavas are found along Turgeon river where also rounded and subangular inclusions of a lighter-coloured rock can be seen.

The examination of ten thin sections of the rock shows that the homogeneity of aspect in the field is unreal and that the map unit consists of several kinds of rock. The diversity of mineralogy and texture suggests that the grey gneisses are of mixed origin, being partly ortho-gneisses and partly relics and modified relics of older formations.

The most consistently present mineral is plagioclase, which shows diversity in composition from specimen to specimen as well as zoning, commonly oscillatory, in a single grain. Some of the plagioclase is as calcic as An_{40}, but most of it is less so. Many grains are largely composed of An_{20}, but even these have a tendency to have albitic rims. Some of the oligoclase has myrmekitic quartz. Potassic feldspar is from traces to about a sixth of the rock. Some of it shows moiré twinning, but some is feebly twinned or devoid of twinning. Both the plagioclase and potassic feldspar in some thin sections show clouding by fine alteration products. In many of the plagioclase grains the clouding is accompanied by recognizable grains of minerals of the epidote group.

The characteristic dark mineral is biotite, which is commonly altered to chlorite. However, biotite is not abundant in the thin sections although widely distributed in the rocks. Several varieties of hornblende occur; one variety has optical properties similar to those of the amphibole in the diorite complex, and some is pleochroic in blue-green with a low birefringence and small optic axial angle.

The accessory minerals are apatite, sphene, zircon and opaques.

Medium-grained Pink Granitic Gneiss and granite

Several rocks have been mapped as this unit; they are exposed at a number of places in the southeast corner of the area. They are generally pink or pinkish, some varieties being pinkish grey. In most exposures they are medium-grained, but in some places they are to the naked eye fine grained, and porphyritic varieties occur in which microcline crystals are 3/4 inch long. The gneissic structure can be seen in most exposures, but it is not obvious in some. Inclusions of amphibolite occur in several places and are cut by dykes of pink granite, some of which is the fine-grained variety.

The thin sections show little uniformity, particularly of texture. In some rocks the grains of feldspar are equant with the plagioclase grains tending to have crystal boundaries but in others the grains form an equant mosaic. In some thin sections the margins of grains appear to be granulated, with biotite or chloritized biotite or white mica enclosing grains of quartz and feldspar. This texture can be attributed to paulopost alteration.

The plagioclase, which is mostly an oligoclase, is somewhat zoned but less so than in the medium-grained grey granitic gneisses. Some alteration is apparent. Microcline is more abundant than in the grey gneisses and is commonly twinned. The tenor of quartz is variable but does not exceed one-third of the rock.

The dark minerals are not abundant. Some specimens could be called alaskite gneiss. The commonest dark mineral is biotite, much of which has been converted to chlorite. Some of the biotite encloses grains of other minerals in a fashion suggesting its late growth, and a white mica has a similar habit to an even greater extent.

Sphene, apatite and zircon are accessory minerals and minerals of the epidote group are alteration products.

Coarse-grained Pink Granite

A coarse-grained pink granite crops out at several places close to the southern boundary at its eastern extremity. At some localities this granite can be seen to cut the gneissic variety.

The microscope shows that this rock is largely a hypidiomorphic granular aggregate of plagioclase, microcline and quartz. The properties of the minerals are similar to those in the pink gneisses although zoning of the plagioclase is not so great.

Locally the effects of shearing are visible in the granite, and, in at least one place, quartz veins have developed along the S surfaces.

Pegmatites, Aplites and Granophyres

Dykes of pegmatite in the area are thin and are found in the granites and granitic gneisses or in the greenstones near granitic rocks. Numerous thin dykes of pink aplite were seen near the southwest corner of the area. These rocks have microcline in addition to oligoclase. What is perhaps an aplite but containing andesine and quartz forms a fine-grained greenish grey dyke cutting quartz diorite along Turgeon river.

A light grey, fine-grained granophyre forms a dyke 8 feet thick in the gneissic granite near No. 2 rapids on Turgeon river. It is composed of phenocrysts of andesine surrounded by a granophyric intergrowth of quartz and feldspar.

Diabase and Lamprophyre

A diabase dyke, 100 to 200 feet thick, which strikes about N.50°E., crosses the southeast part of Laberge township and continues into Paradis township. The dyke is resistant to erosion and can be traced by exposures through part of its course, but in some parts its position was inferred from differences in the size and density of trees on its projected course.

The dyke shows prominent joints and yields to erosion by forming spheroidal weathering surfaces, which are ordinarily rusty brown. The rock on fresh surface is dark greenish grey and is medium grained except near the margins of the dyke where it becomes fine grained.

Although the weathered surface shows in places traces of ophitic texture, the thin sections show considerable diversity of fabric. In some thin sections laths of plagioclase lie next to laths of pyroxene; in another labradorite includes pyroxene poikilitically. No trace of olivine can be seen, although some alteration products may be its pseudomorph. However, quartz is present in small amounts in some thin sections and, particularly because some of it is in granophyric intergrowth with feldspar, quartz is considered primary. Therefore, at least part of the dyke can be considered to be quartz diabase.

Several tabular bodies, from 1 foot to 15 feet thick, consisting of intermediate plagioclase and secondary amphibole, occur in the diorite complex. The alteration has obscured the original mineralogy of the rock but they are mentioned here because they have a chemical composition approaching that of the diabase.

Several medium-grained, dark greenish black dykes from 4 inches to 15 feet thick cut the rocks of the diorite complex. Because abundant grains of biotite and hornblende are visible in hand specimen, the rocks were called lamprophyres in the field. The study of a thin section neither confirms nor denies this interpretation. The rock consists of large grains of biotite and hornblende in a matrix with alkali feldspar and carbonates. The accessory minerals include pyrite and sphene and are abundant.

PLEISTOCENE AND RECENT

The greater portion of the area is overlain by deposits of silt, clay, sand, and gravel of glacial origin. Silts and clays are widespread, whereas sand and gravel are best exposed in the east.

A prominent esker-like ridge, partly buried by an outwash deposit, trends N.30°W. across the area. The outwash deposit is marked by a line of kettle lakes.

Low ridges or mounds of silt, sand, and gravel in the more swampy areas are elongated parallel to the movement of the ice.

The larger streams and rivers have exposed boulder beds at a number of places, giving rise to rapids in many sections. Where the streams have exposed bedrock, beautifully striated surfaces are common. Other than in stream beds, striations are well exposed on recently uncovered lavas, and also on a prominent hill of pink gneissic granite in the southeast (Plate I-A), just west of Ménard river. The glacial striae vary in strike, S.17°E. - S.40°E., but average S.30°E. Grooves in the more weathered outcrops also indicate the trend of ice movement.

North and northwest slopes of hills and rock outcrops are comparatively smooth, whereas south and southeast slopes are steep and rugged, owing to plucking of joint blocks by the moving ice (Plate VIII-A).

Preserved boulder beaches occur at several levels high on the flanks of the prominent hill mentioned above. They are approximately 25-50 feet wide, and consist of subangular boulders 3 inches to 2 feet in diameter, mostly of local origin. As the beaches are devoid of vegetation they appear on aerial photographs as narrow white lines contouring the west and east flanks of the hill. Similar boulder beaches have been described in neighbouring areas (Wilson, J.T., 1938, p. 2; Tiphane, M., 1959, p. 10, Plate IV; Geol. and Econ. Min. of Can., 1957, p. 480, Plate LIII) and their origin is ascribed to the changing position of glacial lake Barlow-Ojibway, which formed between the retreating ice sheet and a height-of-land to the south. The lake waters covered almost all the area, though several of the higher hills probably projected as islands. Wilson (1938) found undisturbed boulder clay above the level of the highest beach on Plamondon Hill in the area to the east. He took this to indicate that the hill was never completely submerged.

The clays of the area are probably for the most part lucustrine. Although no varved clays were observed, time did not permit a careful search and their presence may have been overlooked.

Erratic boulders up to 25 feet in diameter are scattered over the area (Plate VII-B). The larger boulders are usually within a few miles of known outcrops of similar rocks.

Across the southern part of the greenstone belt many small erratics are granite, suggesting that the central greenstone area, devoid of outcrop, may be partly underlain by granites. A few boulders of conglomerate, mostly small but one about 10 feet in diameter, occur in the southeast corner of the area.

STRUCTURAL GEOLOGY

Schistosity and Foliation

The hornblende schists and amphibolites seem to strike roughly parallel to the granite contacts. However, exposures are few and the rocks highly deformed. Dips vary from 40-90°. Lineation plunging to the southwest occurs in the volcanics near Audet camp.

Gneissosity in the diorite complex strikes easterly, roughly parallel to its contact with the greenstone belt.

The grey biotite granite is well foliated on Turgeon river where it strikes N.30°W. and in Laberge township where the strike is a little east of north. Farther east the rock becomes more massive.

Gneissosity in the pink gneissic granite varies in strike between N. and N.45°W.

Folds

The metavolcanic and metasedimentary rocks have been intensely folded. Top determinations on pillow structures gave ambiguous results and the high degree of deformation makes them unreliable. Near Audet camp contact features between a volcanic agglomerate and a lava flow indicate that the beds have been overturned, at least locally. Small drag folds were seen at a few places in the amphibolites. Intense drag folding occurs in the mica schists in the nose of the volcanic-sedimentary group projecting east of Le Roux road. However, scarcity of outcrop makes the structure in the area very difficult to decipher.

Faults and Shear Zones

A 4-foot-wide breccia zone occurs on Turgeon river at the contact between granite and hornblende schist, cutting across both rocks. In the southeast, near the Paradis-Lemaire township line, in the coarse-grained pink granite, is a zone of highly sheared rock, cut by numerous quartz veins. Both the breccia and the shear zones strike about N.30°W.

Jointing

Joints, generally in three sets, are well developed in the granitic rocks. Two sets at right angles dip steeply; the third is nearly horizontal. This is well illustrated in Plate VIII-B.

Joint patterns were also studied on aerial photographs. Those of the diorite complex are fairly consistent. The most prominent directions average N.30°W. and N.50°W. Roughly perpendicular to these two sets, though not as prominent, is a set striking N.40-60°E. Other sets are also present but of less importance. In the pink biotite granites the joint pattern is similar, though not pronounced. The seeming prominence of the northwest-striking joints may be due to this trend coinciding with the direction of ice movement.

ECONOMIC GEOLOGY

Interest in the district has been shown in recent years and large blocks of ground in the greenstone belt have been staked. Owing to the scarcity of outcrop and the generally thick overburden, geophysics has played an important role. An airborne magnetometric survey has been made, as well as a certain amount of ground magnetometer and gravimeter traverses. Drilling has been done on certain claims. At the time of writing (1963), however, the results of this work were not yet available.

Mineralization in the Volcanics

Fine streaks of pyrite and pyrrhotite with traces of chalcopyrite are present locally in the amphibolites. A sample from 1 mile northwest of Audet camp assayed 0.05% copper, 0.02% zinc, and 0.01% nickel. A second sample taken just south of Audet camp assayed 0.05% copper, 0.01% zinc, and 0.04% nickel. Sheared amphibolite associated with the breccia zone on Turgeon river carries pyrite and a little chalcopyrite. Assay values were 0.7% copper, 0.02% zinc, 0.01% nickel, and 0.03% cobalt.

Cubes of pyrite up to 1/4 inch square occur in the impure quartzites northeast of Audet camp.

Disseminated pyrite is commonly present in all the volcanic rocks.

Mineralization in the Diorite Complex

Cubes of pyrite occur in clusters along fractures and associated with chlorite in a coarse-grained diorite in the southwest corner of the area. Pyrite is also present in the dioritic rock on Turgeon river. Elsewhere it occurs as disseminated cubes.

Mineralization in the Pink Granites and Gneisses

Disseminated pyrite occurs in both the granitic and gneissic varieties. The shear zone in the coarse-grained pink granite contains a little pyrite and thin stringers of purple fluorite.

Pleistocene

Boulders of chert with bands rich in magnetite and pyrite are present in boulder deposits across the central portion of the area. They are probably derived from beds interbedded with the volcanics, and are similar to cherts described by Thomson (1937, p. 56) in the Burntbush River area, and by Tolman (1951, p. 9) in the Normetal Mine area. Such horizons should be taken into account when evaluating magnetic anomalies.

Large quantities of sand and gravel are available along the esker in Laberge and Paradis townships. Smaller hills and ridges of sand and gravel near Audet road could also be utilized.

Recommendations

In searching for ore deposits in an area such as this, much dependence must be placed on geophysics and drilling. The presence of sulphides, though in traces, in the few surface exposures is encouraging, as is also the similarity of many of the rock types to those of the Normetal Mine area (Tolman, 1951) to the south. The structural control of that ore body is zones of shearing in sericite and chlorite schists.

In the present area it could be that, with suitable conditions and the right structural control, concentrations of ore minerals have formed. In this respect the breccia and shear zones previously mentioned may warrant investigation.

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ALPHABETICAL INDEX