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CHERTSEY AREA, JOLETTE, MONTCALM AND TERREBONNE ELECTORAL DISTRICTS

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GEOLOGICAL SURVEYS BRANCH

GEOLOGICAL REPORT 93

CHERTSEY AREA

JOLIETTE, MONTCALM AND TERREBONNE

ELECTORAL DISTRICTS

by

P.-E. CÔTÉ

QUÉBEC
RÉDEMPTI PARADIS
PRINTER TO HER MAJESTY THE QUEEN

1960

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CHERTSEY AREA

JOLIETTE, MONTCALM, AND TERREBONNE

ELECTORAL DISTRICTS

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INTRODUCTION

General Statement

The area is underlain mainly by the eastern part of the Morin anorthosite mass and associated rocks, by Grenville rocks, and by grey granite gneiss, in that probable order of age. The youngest consolidated rocks are diabase dykes. All are Precambrian.

The general structural trend of the rocks of the area is north-northeast.

Economically, the area gives some promise in the traces of silver and lead, showings of titaniferous iron, and presence of consolidated rocks that may have some future industrial use.

Location and Access

The Chertsey area, mapped during the summer of 1947, is in the Laurentian region about 40 miles north-northwest of Montreal. It is bounded by latitudes 46°00' and 46°15' and by longitudes 73°45' and 74°00', and comprises an area of approximately 210 square miles. It includes almost all of Chertsey township, and parts of Chilton, Rawdon, Kilkenny, Wexford, and Cathcart townships. All but the last two townships are in Montcalm electoral district. Cathcart township is in Joliette, and Wexford township is partly in Montcalm and partly in Terrebonne electoral districts.

Highway No. 18, which joins Saint-Donat to Montreal *via* Sainte-Julienne, crosses the southern part of the area. Secondary gravel roads branch from the highway and render most of the southern half of the area easily accessible by car. Access to the northern half of the area depends on a few truck roads, trails and portages.

Previous Work

The first geological work done in this area was by Sir William Logan. In the "Geology of Canada" of 1863, he describes the fine-grained anorthosite lying between Chertsey and Rawdon. To Logan, these rocks were part of the "Fundamental Gneisses" which he considered to be meta-sedimentary. Adams (1895) studied the Morin anorthosite massif and the metamorphic rocks that bound it on the east, south, and west. The present report covers only a small part of the area described by Adams. No more recent geological work has been done in this area, although Osborne, a few years ago (1935; 1936), examined the rocks that bound the Morin massif on the west, southwest, and south.

Field Work and Acknowledgments

Compass traverses were made at half-mile intervals and were plotted on a scale of two inches to one mile on a base map furnished by the Surveys and Mapping Branch, Department of Mines and Technical Surveys, Ottawa. A complete series of vertical aerial photographs (Royal Canadian Air Force) covering the area also was supplied by this Branch and proved most useful in the field work.

The writer was most ably assisted in the field work by M. Mousseau Tremblay, a student at Université de Montréal.

DESCRIPTION OF THE AREA

Topography

Ouareau river drains most of the area, and some smaller streams flow directly into the Assomption, Rouge, Saint-Esprit, and Achigan rivers. Ouareau river, which is about 150 feet wide, rises in Archambault and Ouareau lakes, northwest of the area, and flows south-southeasterly across two-thirds of the area. It then swings sharply east for 4 miles before crossing the eastern border of the area and assuming an east-southeasterly course to finally discharge into Assomption river, a tributary of the St. Lawrence.

The area can be divided into three districts, each with a distinctive relief and drainage pattern, and each underlain by rocks of different character.

The largest of the three districts covers most of the southern two-thirds of the area, and is underlain mainly by sheared rocks.

Many smooth, rounded hills rise some 500 feet above the valleys. In this district, the Ouareau flows in a broad pre-glacial valley, and is fed by numerous small streams which flow in rather large valleys. The trends of most of these valleys are at right angles to that of the Ouareau, thus forming a roughly rectangular drainage pattern. The valley walls have been further sculptured by subordinate streams, which have carved out a series of roughly aligned hills. Continental glaciation smoothed the ridges, deposited a thick veneer of drift, and produced the characteristic mammillated topography. Glacial drift has blocked the outlets of many of the transverse valleys to form numerous lakes in the region.

Stony, Beaurivage, and Castor creeks, and Ouareau river, in its southeasterly course, are the only major streams that tend to parallel the foliation of the underlying sheared anorthosites. All other pre-last-glacial streams, as well as the Ouareau in its easterly course, trend across the structure of the bedrock (Plate III-B). Such a drainage pattern could not normally have been formed on the strongly-foliated rocks which now underlie the region; it must have been inherited from a drainage pattern previously developed on rocks at one time overlying the sheared anorthosites.

The regions underlain by coarsely-crystalline anorthosites, that is, the northwestern and the western border sections, are noteworthy for a local relief of the order of 900 feet. Here, Ouareau river flows in a very straight, narrow, recently cut valley, characterized by almost continuous rapids and several cut-off spurs. The course of this part of the Ouareau is controlled by two sets of joints with parallel strikes but steep dips in opposite directions. Secondary streams in this area trend in a general east-west direction; their valleys are all definitely broader than that of the Ouareau in its upper reaches. Valley walls are high and commonly rounded, but they may be steep in places; they are less commonly indented by subordinate streams than are the valley walls to the southeast. Locally, glacial erosion is marked in these massive rocks, but the mantle of drift is thinner and has not masked the relief as much as in the sheared anorthosite. Lakes, formed by drift blocking pre-glacial valleys, are not numerous.

The upper Ouareau flows in a narrow, youthful valley (Plate II-B), which is in strong contrast with the breadth of some of its tributary valleys such as those occupied by Toussaint lake and Beaulme river. These tributary valleys are incised in the same massive anorthosite without being favoured by such definite structures as those controlling the Ouareau, but they have developed much broader valleys than that of the main stream. This leads to the conclusion that the Ouareau, in its upper reaches, is following a relatively new course, probably the valley of an ancient tributary. Narrow terraces cut in rock along the straight stretch of the Ouareau point to a relatively recent rejuvenation, probably connected with the post-glacial uplift. The modification of the drainage probably occurred in Pleistocene time. There are two possibilities: either the Ouareau originated within this area and the waters from the north flowed easterly in the Cadieux and Versailles valleys, which lie north of the area and roughly parallel the north border, or, more probably, the waters flowed southward from the present Ouareau and Archambault lake districts, and passed through a gorge into the present Beaulme valley, to enter the broad Ouareau valley.

The third physiographic district lies along the northeastern part of the area and is underlain by Grenville rocks, The land surface here is much lower than in the two districts discussed above. Sharp hills separating the streams, which are arranged in a trellis to sub-parallel pattern, have a marked, although low, relief. Lines of low hills trend parallel to the strike of the Grenville rocks. The linear pattern of both drainage and hills, and its influence on the vegetation, is well shown in aerial photographs (Plate II-A). The topographic pattern appears to be controlled by the relative resistance of the various folded Grenville strata.

Natural Resources

With the exception of the rugged northwestern part of the area, most of the region was at one time opened for land-settlement. Much of this land proved unsuitable for farming and has been allowed to revert to bush. Farming is still carried on near the present roads, mainly along the terraces of Ouareau river where it maintains an easterly course. Much of this land has been sold as sites for summer cottages. Many of the other farms are evidently marginal, and it is probable that in the future they too will be abandoned.

During the war years the timber industry took on major importance in the area and the timber reserves were largely depleted. The inhabitants are turning their attention more and more to the tourist trade, and are developing summer resorts on the many beautiful lakes that dot the area.

GENERAL GEOLOGY

The Chertsey area is on the eastern fringe of the Morin massif mapped by Adams (1896). A coarse-grained, massive anorthosite, characteristic of the main body to the west, crops out along the western boundary of the area and grades to the east into finer-grained anorthosite.

The anorthosite is separated from Grenville rocks to the east by a series of rocks varying from quartz diorite to grey granite gneiss through quartz mangerite gneiss. Granulated facies are common and could not be separated on the map. The sheared quartz-mangerite cuts the anorthosite and the quartz-mangerite.

A dark grey to chocolate-brown granite occurs along the eastern contact of the Grenville rocks of the south central part of the area, and it extends westward into the massive anorthosite.

The Grenville rocks, which are considered as the oldest in the area, are exposed in concordant masses in the south central part and in the northeastern corner. They are quartzites, crystalline limestone, amphibolite, quartz-feldspar gneisses, and garnetiferous as well as graphitic gneisses of various compositions. Sills of gabbro also occur within the quartzite.

Glacial drift veneers the whole area, but it is thicker in the central and eastern parts than in the more rugged sections underlain by massive anorthosite. Fluvioglacial gravels, similar to those shown in Plate V-A., form several broad plains along Ouareau river. These are best seen at two localities: one south and east of the Grande Jetté, the other along that part of the river where it broadens and flows eastward. In the southeast corner, several exposures of bluish-grey varved clays were observed at elevations of approximately 520 feet.

Table of Formations

Cenozoic	Recent Pleistocene	Stream sand and gravel Moraine, outwash sand and gravel, clay
PRECAMBRIAN		Diabase
		Jean Venne granite
	Intrusive contact	
	Morin Series	Granulites: pink granite gneiss, sheared quartz-mangerite gneiss, quartz diorite gneiss Quartz mangerite: green augen gneiss to coarse microbreccia Chertsey facies: sheared and microbrecciated anorthosite Ashton facies: massive anorthosite
	Intrusive contact	
	Grenville Series	Quartzite, crystalline limestone, quartz-feldspar-garnet gneiss, amphibolite, gabbro sills

GRENVILLE SERIES

Grenville rocks occur mainly in two principal localities in the area: a long narrow "wedge" that trends in a northwesterly direction from the centre of the southern boundary, and a roughly triangular area in the northeastern corner. The latter is a more characteristic development of Grenville rocks than the former, but both are mainly strongly foliated, highly metamorphosed, inter-banded gneisses of various types. They have a great diversity in composition, and their origin must be in part sedimentary and in part igneous.

A prominent member of the series is a greenish grey, markedly sheared quartz-feldspar-garnet gneiss. The groundmass consists principally of quartz and feldspar. Red garnet porphyroblasts make up 10 to 50 per cent of the rock, in grains generally about 8 mm. in diameter although varying from 1 to 12 mm. Graphite and mica are common accessory minerals.

Under the microscope this rock shows a mosaic of anhedral potassic feldspar, probably microcline, up to 0.3 mm. The quartz is interstitial, generally laminated and commonly has minute inclusions of rutile or sillimanite. The garnet contains inclusions of feldspar. Some mica and iron ores are present. One thin section showed 15 per cent of sillimanite in fine needles.

Another common member of the Grenville is a light to dark grey, fine-grained rock, with prominent fine flakes of graphite. The microscope shows this rock to be a very impure quartzite containing 50 per cent quartz, 3 to 10 per cent graphite, much feldspar, and some chlorite and sericite. One thin section has a few coarse grains of sillimanite.

Adams (1895) has described a rusty-weathering gneiss which accompanies the crystalline limestone and is present at several places in the area. This rock is very irregular in texture, consisting essentially of very fine-grained quartz with some porphyroblasts of orthoclase. The main accessory minerals are garnet, graphite, and iron ores. Small needles of sillimanite or rutile occur within both the quartz and the feldspar.

Some fine-grained garnetiferous "gneisses" have a greenish grey colour and a conchoidal fracture suggestive of the sheared anorthosites. The garnet crystals are invariably smaller than those of the garnetiferous gneiss described above. A few lamellae of quartz are present in some specimens. These "gneisses" commonly have considerable plagioclase feldspar, the calcity of which varies widely but invariably lies within the range of that of the anorthosites. In some localities, the quartz bands are so coarse as to give the rock a typical Grenville appearance. Such rocks were mapped with the quartz diorites except where found within the area of predominant Grenville types. They may be intrusive, but the bodies are too thin to be mapped separately.

Layers of coarse, slightly impure, rusty weathering quartzite are common. Few of the layers are more than 20 feet thick.

Accessories are feldspar, calcite, biotite, clino-pyroxene, and serpentine. The quartzites are commonly associated with garnetiferous gabbros.

The garnetiferous gabbro is chiefly composed of augite with some hypersthene; plagioclase (An_{70}) forms about 25 per cent of the rock and garnet may be as abundant. The accessories include hornblende, sericite, biotite, calcite, apatite, and iron ores. Although there may be a genetic relationship between these gabbros and the anorthositic rocks, the texture of the gabbro, the high calcity of its plagioclase, the absence of interstitial potassic feldspar and lamellar quartz, and the presence of hornblende, biotite and sericite must be classed as characteristic of the gabbro but not of the anorthosites.

Apart from the above, a metagabbro is found near the northeast corner of the area. This is an equigranular, non-banded, fine-grained, sheared rock which grades into a well-banded amphibolite and a lighter coloured gabbroic rock. The former consists essentially of hornblende and plagioclase (An_{56}) with some accessory hypersthene. Amphiboles have never been observed in large amounts in the normal anorthositic rocks. However, the presence locally of 10 per cent orthopyroxene, lends weight to the belief that this rock may be part of the anorthosite series with which it has been mapped.

A few small exposures of crystalline limestones were seen, the largest being along the old Saint-Alphonse - Saint-Côme road. It is about 20 by 40 feet and is in the marble quarry described by Adams. These exposures seem to belong to one and the same band. The limestones vary markedly in composition. Some are made up of a relatively pure aggregate of coarse calcite or dolomite crystals; in others the calcite is fine-grained and associated with quartz. Mica, commonly phlogopite, is abundant and some crystals are 2 inches in diameter. Serpentine forms pods from 0.1 to 0.2 mm. in diameter. An ophicalcite with a cloudy green colour is formed where serpentine is abundant.

Several skarns derived from limestones are present close to igneous rocks. These rocks are dull greenish grey, massive, heavy, and very tough. They vary in composition from a diopside rock, through an impure pyroxenic variety, to an impure marble with abundant disseminated greenish minerals and common apple-green aggregates made up of diopside and scapolite. Other minerals are residual calcite, garnet, plagioclase, and serpentine.

Of the rocks described above, all but the gabbros are believed to be meta-sedimentaries. Apophysis-like penetrations of lime rocks into country rock have been reported, and one instance of this was observed in the present area. Such "injections" have been satisfactorily explained as a result of the plasticity of the limestones under heat and pressure. The quartz-feldspar-garnet and the quartz-feldspar-graphite gneisses have some sillimanite, a mineral characteristic of meta-sedimentary rocks. Only the layer of limestone could be related to bedding. Even so, very few members of the original Grenville complex of this particular region are thought to be of igneous origin. These include two definite orthogneisses which are commonly associated with the Grenville rocks, namely, a sheared quartz-mangerite, and a pink granite gneiss. These intrude the anorthosite, and must, therefore, be younger than the rocks of the Grenville series

In addition to the two intrusive gneisses there are other rocks which appear to be orthogneisses; all are in small bodies conformable to the neighbouring rocks. Two of these show much leafy quartz, which is believed to have been injected, and of these two one resembles an impure quartzite except for the leafy and pencil-like arrangement of aggregates of quartz separating thinner layers of pink microcline. Augite, biotite, and limonite are the mafic accessories.

The coarse quartz foliae are more prominent in another gneiss. This rock is made up essentially of a perthitic potassic feldspar clouded by sericite, a little plagioclase with some secondary calcite, approximately 20 per cent garnet, and 20 per cent quartz, some of which contains inclusions of feldspar. Still another gneiss is very leucocratic and fine-grained, its generally light grey colour being broken by occasional fine garnetiferous bands and thin foliae of quartz. Its texture under the microscope is similar to the much sheared members of the anorthosite group.

MORIN SERIES

Anorthosite

Most of the Chertsey area is underlain by anorthositic rocks. These are not uniform, varying considerably in colour, grain size, texture, composition, and structure.

The main Morin massif has its centre approximately 8 miles west of Patrick lake. There, the anorthosite is coarse-grained, massive, and similar to that of the band along the western boundary of the present area. Towards the east, this rock grades into a finer-grained, commonly layered and sheared anorthosite. The width of exposure of this sheared border rock is very much greater than that of any other variety of anorthosite in the area. The band is 5 miles wide at the northern limit of the area and reaches a maximum of 10 miles near the centre. Some anorthosites of this variety were called "Chertsey facies" by Adams, and this name is used here for the sheared anorthosite. The coarse-grained anorthosite is termed the "Ashton" facies, a designation suggested for purposes of this report only.

Ashton Facies

This rock is coarse-grained and rather dark, varying from a reddish to a greenish colour depending on the colour of the plagioclase. It is made up essentially of plagioclase with varying amounts of pyroxenes and some titaniferous iron ores. Abundant pyroxenes or iron minerals give the rock a darker shade. The weathered surface is commonly light grey but may be rusty if even minor amounts of mafic minerals are present.

The granularity of the rock is quite variable, between coarse and medium. These variations are not related to the contact, as the coarsest anorthosite was observed in the vicinity of Ashton lake, only one mile from the border of the Chertsey facies. A blocky structure consisting of brecciated fragments of the coarser rock surrounded by finer anorthosite was found at some localities.

Porphyritic textures are common, the phenocrysts being mainly of plagioclase. When pyroxene phenocrysts are present they are normally accompanied by still larger crystals of feldspar. In some places plagioclase crystals as much as 6 inches long are common; the largest observed is more than 2 feet long. The phenocrysts and, in places, the mafic minerals tend to assume a rough parallelism commonly too indistinct to be measured. Where measurable, these planes dip west at angles somewhat steeper than that of the foliation of the Chertsey facies.

Under the microscope the plagioclase (An_{50}) grains, with well-developed twinning lamellae, are seen to form a mosaic texture. It commonly also shows strain shadows and an incipient to a marked peripheral microbrecciation. It should be noted that the brecciation is around the grain and has not been observed to transect a crystal or a group of crystals. Minute inclusions cloud all the plagioclase crystals. It is generally admitted that the colour of the plagioclase is caused by these inclusions.

Orthopyroxenes, clinopyroxenes, and iron ores are the common mafic minerals of the Ashton facies. The two pyroxenes are pale green augite and hypersthene, the latter strongly pleochroic in pink and green tints. In these rocks, the augite to hypersthene ratio is approximately 4 to 1.

The textural relationships of the pyroxenes to the plagioclases are indefinite even in the totally unsheared rock. Normally the pyroxenes are anhedral and appear to be interstitial to the feldspars. However, a crystal edge of orthopyroxene may abut against several anhedral grains of feldspar. Plagioclase is also observed between grains of pyroxene and rounded feldspar inclusions have also been seen within the pyroxene. It should be noted that the minute inclusions within the plagioclase, referred to above, are believed by some writers to be minute crystals of pyroxene.

The iron ore minerals are invariably interstitial to both the plagioclase and the pyroxenes. They are more abundant near pyroxenes.

Chertsey Facies

As already noted, the anorthosite of the Ashton facies exhibits locally an obscure foliation. This may be the result of brecciation, shearing, or parallelism of phenocrysts. The foliation becomes more pronounced towards the east. Eastward, also, the plagioclase phenocrysts become less abundant and the mafics increase, the grain size generally decreases, and the rock tends to be lighter in colour, being between a blue greenish grey and a tinted white. This sheared portion of the anorthosite constitutes the very broad "contact zone", or Chertsey facies, lying between the main massif and the Grenville country rock.

The change from the massive to the sheared rock is very gradual and the boundary shown on the map between the Ashton facies and the Chertsey facies is quite arbitrary. Also, in the area underlain by the Ashton facies there are banded anorthosites characteristic of the Chertsey facies. An example is the large outcrop on the north side of the valley of Toussaint lake close to the valley of Ouareau river. Such occurrences are of a relatively small areal extent and have not been separated on the map. Similarly, there are a few "outliers" of Ashton anorthosite within the area mapped as Chertsey facies; one such is at the Fifth chute on Ouareau river east of the village of St. Théodore.

The Chertsey facies is characterized by a fine to very fine grain. Under the microscope, this is shown to be the result of either protoclastic or cataclastic deformation. As will be seen later, comparison with the brecciation of the main mass leads to the belief that this is, in fact, cataclastic.

Unbrecciated plagioclase crystals are found in most specimens from western exposures. As the eastern contact of the anorthosite is approached, remnants become the exception rather than the rule. The relics generally tend to be elongated parallel to the foliation (Plate VII-A). Further, such remnants, almost invariably show a good twinning, possibly a glide twinning, parallel to the (010) face. A noteworthy fact is that the twinning planes have become alined at approximately thirty-five to forty degrees from the plane of the foliation. It will be seen in the accompanying photomicrographs (Plates VI-A, VI-B, VII-A) that most relic crystals show a strong deformation, indicated mainly by curved cleavage planes and undulose extinction. These features show that the deformation occurred after these particular grains were crystallized.

In certain places, particularly in the region outlined by a triangle having its apices respectively at St-Théodore, Vails lake, and Cliff's Corner, remnant crystals are made prominent in the Chertsey facies by their pinkish colour as well as by their curved cleavage faces. Indeed, in the coarser varieties of anorthosite within this area, these cleavage faces frequently resemble a conchoidal fracture.

The remnants, however, form only a very small part of the Chertsey facies. The "groundmass" or microbrecciated portion is made up of innumerable grains of granulated plagioclase showing a laminated micro-structure suggesting that of effusive rocks. The diameter of the granules is between 0.01 mm. and 0.12 mm.; the most finely crushed members can thus be termed mylonites. Normally, the grain boundaries of the minerals in the microbreccias are indefinite, but in a few of the coarser facies the grains have sharp boundaries; this is taken as an indication that some recrystallization may have followed microbrecciation.

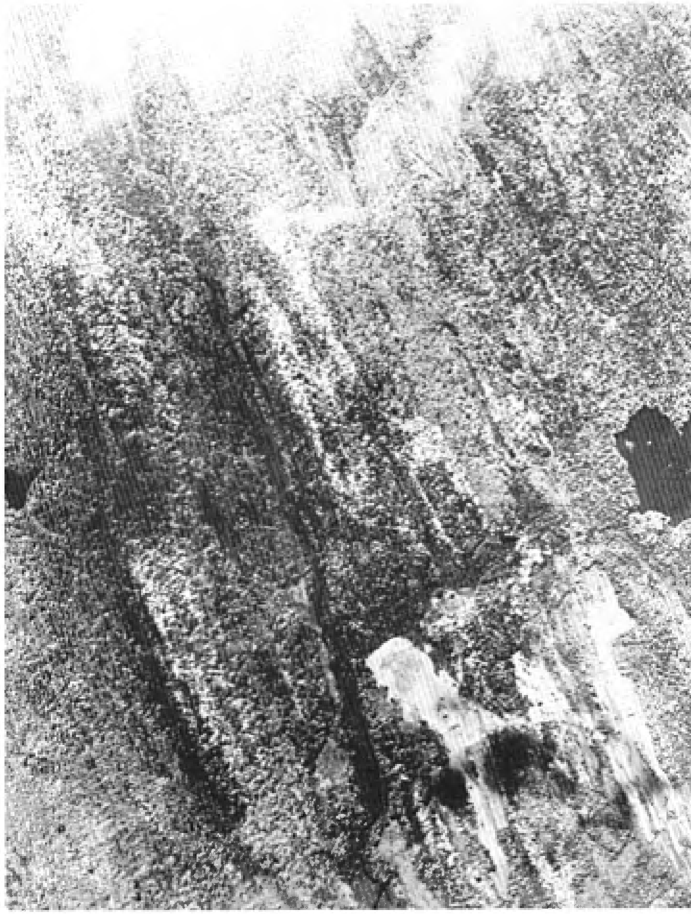
The calcity of the Chertsey facies plagioclase ranges from An_{42} to An_{60}. Individual grains of potassic feldspar were not observed in the massive anorthosite. It is usual, however, to find in these rocks a few grains of plagioclase with an antiperthitic structure. In two thin sections of a rather rare rock, found between Pauzé and Lafontaine lakes, an antiperthitic plagioclase (An_{38}) occurs with quartz as the major accessory mineral.

Plate I

A- Skyline formed by hills of anorthosite. Looking N. 10°W. from a hill north of Bissonnette lake.

B- Topography typical of areas underlain by massive anorthosite. Looking N. 35°E. across Beaulme River valley. Ouareau River valley in central background.

Plate II



A-Aerial photograph (R.C.A.F.) of area underlain by Grenville rocks, showing structural control of topography.

B-Looking east across the upper Ouareau, showing narrow valley and truncated spurs.

Plate III

A- Looking eastward from Cathedral mountain down the Noir Creek valley to the junction with the Ouareau.

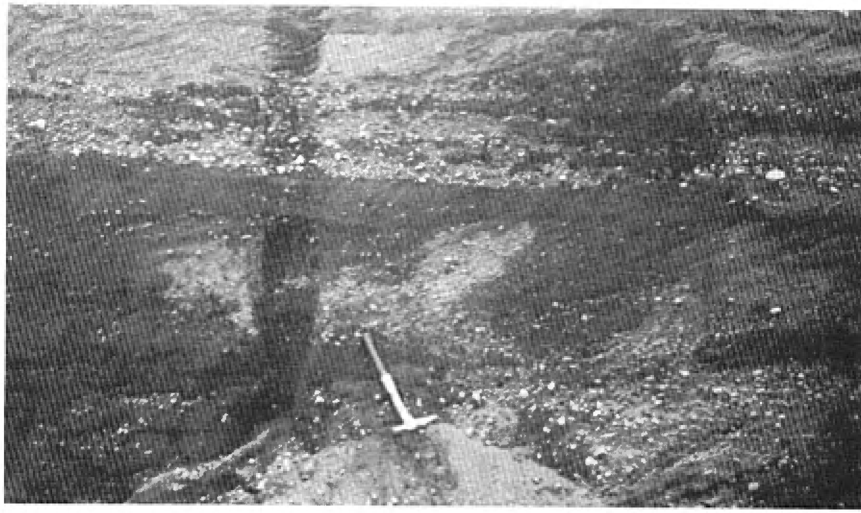
B- Strongly foliated anorthosite at the Fourth chute of the Ouareau river; looking S. 70°W.

Plate IV

A- Showing accentuation of banding in sheared anorthosite as a result of differential weathering of mafic minerals.

B- Anorthositic gabbro with unevenly distributed layering. Southeast end of Rowan lake.

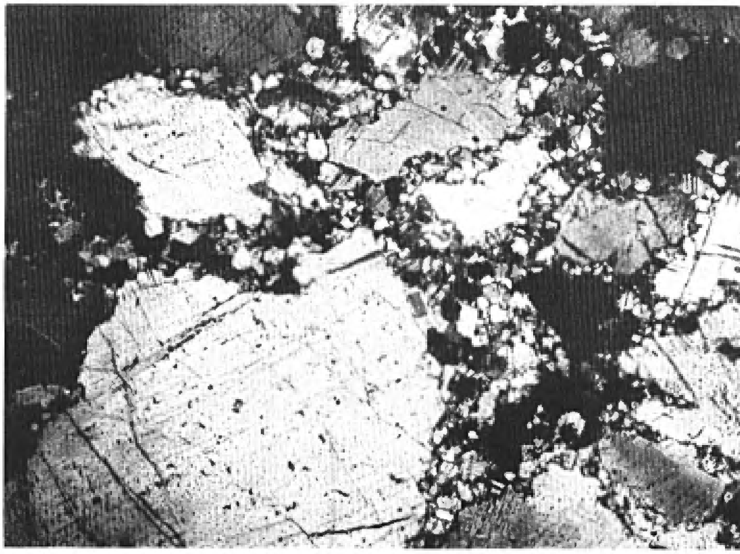
Plate V



A- Gravel in pit by the Ouareau river showing good sorting and cross-bedding.

B- Banded clays in bank of Saint-Esprit river, 3/4 mile northwest of Cliff's Corner.

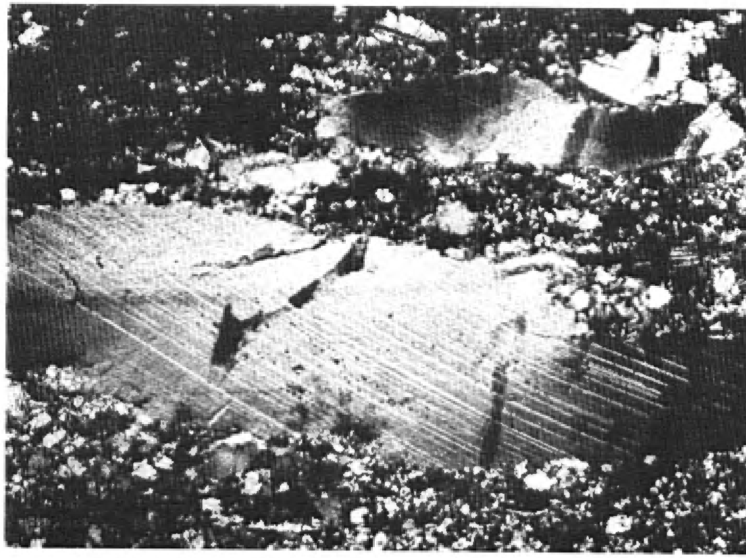
Plate VI



A-Photomicrograph showing first stage of cataclasis of anorthosite: peripheral granulation. (20 X. Crossed nicols)

B-Photomicrograph showing second stage of cataclasis of anorthosite: granulation of plagioclase crystals (20 X. Crossed nicols)

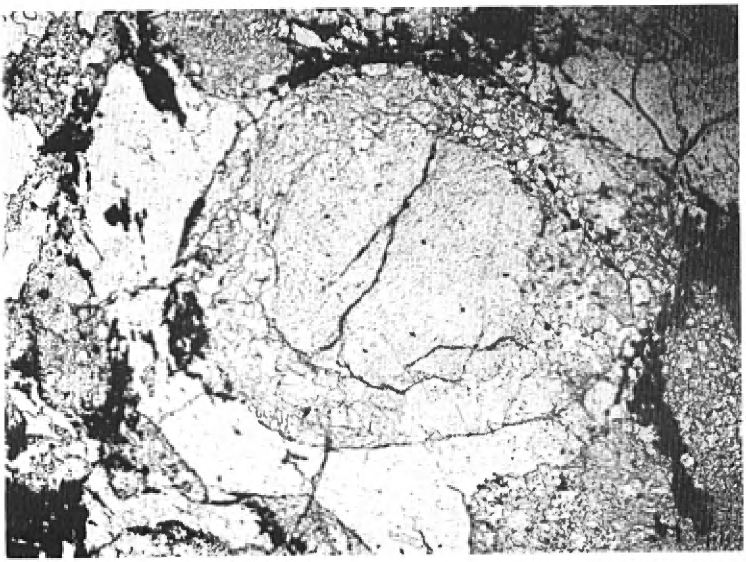
Plate VII



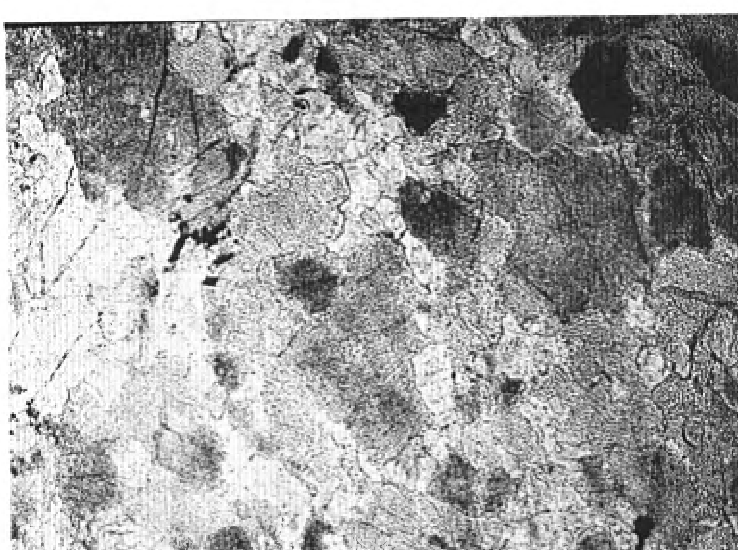
A-Photomicrograph showing later stage in cataclasis of anorthosite. Some crystals (elongated remnants) are rotated so that the twinning planes are at an angle with the plane of foliation. (20 X. Crossed nicols)

B-Photomicrograph showing last stage of cataclasis of anorthosite, with all the rock micro-brecciated. Note alignment of the dark pyroxene (30 X)

Plate VIII



A- Photomicrograph of sheared mangeritic rock showing "pseudo-orbicular" structure probably resulting from rolling. The perthite nucleus ("remnant") is enclosed in a micro-breccia which includes some perthite and is in turn surrounded by quartz grains. (20 X)



B- Photomicrograph of Jean Venne granite showing its unsheared and micro-perthitic character. The light coloured mineral with lower relief is quartz. (20 X)

Probably the most prominent characteristic of the Chertsey anorthosites is a distinct foliation which suggests the bedding of sedimentary strata. This foliation is due, in part, to the lamination of the microbrecciated plagioclase, which makes up the major portion of the rocks, and, in part, to the accumulation of mafic constituents in some layers. The bands may be observed directly, particularly if the concentration of mafics is thick, but differential weathering of the mafics will etch out even very thin laminae and render them quite evident. The thickness of the bands varies considerably across the strike, but, along the strike, it is remarkable for its continuity. The dark bands, vary from .01 inch up to 2 or 3 inches thick. They alternate with leucocratic layers which vary from .1 inch or so up to several feet thick. As both possess a marked continuity along the strike, the parallelism of the structures is noteworthy.

Oblong pits 2 or 3 inches in diameter are found in the Chertsey facies at some localities where the mafic content of the rock is rather lower than average. These pits have been caused by the weathering of small amounts of pyroxenes. The mafic minerals form very thin, short, parallel foliae less than one quarter inch apart.

Quartzose Rocks

The quartzose rocks of the Morin series consist of several remarkably similar and gradational series of which two units are shown on the accompanying map: quartz diorite gneiss and quartz mangerite gneiss. The quartz diorite gneiss is found at the contact with the anorthosite. A strongly sheared quartz mangerite and a pink granite gneiss are included with this unit. The relationships of the pink granite gneiss to the other rocks are not clear.

Quartz Diorite Gneiss

This rock looks much like the fine-grained Chertsey anorthosite into which it appears to grade. Its colour varies from a light greenish grey to a dark olive greenish grey, depending on the percentage of mafics. On weathered surfaces the colour is drab. The apparent grain of this rock tends to be finer than that of the anorthosite, but the only criterion to distinguish it in the field is the occurrence of the thin quartz foliae which can usually be seen by a close examination of the weathered surface.

A specimen of this rock was analysed in the laboratories of the Quebec Department of Mines. The results are shown in Table II, Column I, together with the calculated norm for the rock. The symbol for the rock in the normative classification is I.(II), 4, 3, 4, which is sub-rang Yellowstonose and is a group that contains many analyses of quartz diorite and granodiorite. Column II shows the analysis of a hypersthene granodiorite collected by Osborne. The rock cuts Grenville limestone a short distance south of the southern border of the Morin massif at Saint-Sauveur. This rock has the symbol II, 4, 3, 3 in the norm classification, and is undoubtedly related to the quartz diorite gneiss.

Eleven thin sections of this rock gave the following composition:

Plagioclase (An_{42})	43.0 %
Quartz	25.5 %
Potash-feldspar	9.2 %
Garnet	7.8 %
Iron Ore Minerals	5.5 %
Hypersthene	3.6 %
Augite	2.6 %
Apatite	0.6 %
Biotite	0.5 %
	98.3 %

TABLE II

	I	II	Norm of I	
SiO_2	67.55	61.16		
TiO_2	.59	1.56		
Al_2O_3	14.47	14.13	Q	29.30
			or	8.37
Fe_2O_3	1.54	1.67	ab	29.87
FeO	3.41	6.60	an	19.47
MnO	.10	.05		
MgO	1.29	1.97	an	3.22
CaO	4.32	4.48	hy	4.22
Na_2O	3.52	2.62	mt	2.22
K_2O	1.41	2.81	ll	1.12
P_2O_5	.32	.51	ap.	.73
CO_2	.91	.66		
H_2O +	.59	.83		
H_2O -	.08	.35		
V_2O_3	faint tr.	n.d.		
Cr_2O_3	tr.	n.d.		
NiO	tr.	n.d.		
SiO	faint tr.	n.d.		
Ga_2O_3	faint tr.	n.d.		
	100.10	99.40		

I Quartz-diorite gneiss, Chertsey, analyst H. Boileau
II Hypersthene granodiorite, St-Sauveur, analyst W.H. Herdsman.

Mineralogically the rock is a garnetiferous quartz diorite.

The rock shows some differences from the Chertsey anorthosite. Under the microscope plagioclase grains appear to be somewhat coarser, clearer, and generally show better defined outlines than those of the Chertsey rock. The garnets, when present, are porphyroblastic; alteration products, such as biotite, sericite, hornblende, chlorite and calcite, are more common. These differences all point to a weak metamorphism probably with attendant hydrothermal alteration. The quartz is frequently found interstitially within the microbreccia, but it occurs predominantly as lamellae with an average width of about 0.1 mm.

The quartz diorite gneiss crops out on the northeast side of the area along the 10-mile irregular contact between the main anorthosite body and the Grenville rocks. Sufficient exposures of it have been observed to assume that this border zone is continuous throughout. At the south end of the area, where the Chertsey facies appears to pass beneath the 'wedge' of Grenville rocks, the quartz diorite gneiss is only found here and there. These rocks are also intimately associated with the grey granite gneisses to the northeast. Because of their great similarity it has been impossible to distinguish these two members in the field, but it is probable that they grade into one another. This is borne out by their relation to the main mass of quartz-mangerite to the south: this rock grades locally into sheared quartz-mangerite and these in turn are associated with quartz diorite gneiss.

Sheared Quartz-mangerite

In the field these rocks are very similar to the quartz diorite gneiss. Weathered specimens, however, show a drab colour rather similar to that of the quartz-mangerite. Under the microscope, they appear as a coarse microbreccia having fairly clear grain outlines. They have the following average composition:

Potassic feldspar	36.2 %
Plagioclase (An_{28})	23.2 %
Quartz	29.4 %
Mafics and accessories (hypersthene)	11.2 %
	100.0 %

Potassic feldspar / total feldspar - 0.61

This is the composition of an acidic quartz-mangerite, and the rock is a quartz-mangerite gneiss.

In the rare cases where remnants are found, they are made up of plagioclase. However, most of the plagioclase does not show the pressure phenomena so notable in the sheared anorthosites. Thus, the clarity of the crystals, and the rather simple grain outlines indicate the possibility of recrystallization or crystallization under stress. The potassic feldspars are interstitial as they are in the sheared anorthosites, but these interstices are large, and commonly seem to have coalesced to give space for a solid mosaic of potassic feldspar. The mineral is not very clear, but seems to contain inclusions and products of decomposition. The quartz is later than both feldspars. It tends to be in foliae, but this character is not so well developed as in the previous group; indeed, in many cases, interstitial grains of quartz form more than a third of the quartz content of the rock. Accessories include sideronitic iron ores, euhedral apatite, and anhedral pyroxenes including both augite and hypersthene. Contamination and alteration are indicated by garnet, secondary hornblende, biotite, and sericite.

The sheared quartz-mangerite also commonly forms dykes and sills. The sills are found notably at the contacts between the anorthosite and the southern 'wedge' of Grenville rocks. These contacts form planes of weakness, possibly thrust planes, along which the sheared quartz-mangerite gneiss was intruded. A good exposure of this rock crosses Highway No. 18, one mile southeast of Saint-Théodore village. Sills of these rocks show a strong foliation and a marked lineation.

Dykes of sheared quartz-mangerite cut the Grenville rocks and the anorthosite. A small exposure at the west point of Patrick lake, by the inlet from Des Isles lake, shows the anorthosite cut by a 4-inch dyke of this rock. Behind the cottages lying to the south of the outlet of the lake another exposure shows the same relationships. Thus, the quartz-mangerite must be younger than the anorthosite.

Pink Granite Gneiss

The distinctive pink to reddish colour of the granite gneiss may give it a greater prominence than it deserves. It occurs commonly as thin dykes or sill-like bodies, and is associated with the sheared quartz-mangerite; in fact, it seems in places to grade into the quartz-mangerite, and some specimens of the latter contain much pink feldspar. However, these rocks display relations indicating two separate stages of intrusion, and this is supported by petrographic examination. Thin-section study shows the pink granite gneiss to be a flaser rock made up of perthitic feldspar surrounded by a fine microbreccia of potassic feldspar and laminated by sub-parallel veinlets of interlocked grains of quartz with wavy sutures. This 'granulitic' quartz groundmass curves around the knots of perthitic remnants, giving the rock a 'micro-augen' texture. Mafic minerals (iron ores and biotite) rarely form as much as 4 per cent of the rock. Many of these rocks show secondary alteration as evidenced by sericite and chlorite.

Thin dykes of pink granite gneiss are fairly common. They cut all the rocks of the area except the late granite. Many of these dykes are thin, but short apophyses extending from sills are up to 20 feet thick. The sills of pink granite gneiss are common in close association with the sheared quartz-mangerite, and along contacts between certain formations and other planes of weakness.

The perthitic nature of the feldspar of this intrusive recalls that of the late granite, the only rock of the area not cut by this orthogneiss. Against such an association stand the character and colour of the rocks, their geographical distribution, and the fact that the pink granite gneiss does not contain hypersthene. Hand specimens of this pink granite gneiss are similar to some of the Trembling Mountain gneiss of the Lachute area.

Quartz-mangerite

Quartz-mangerite was seen at several places in the area. The largest outcrop forms a broad 'wedge' which separates the Grenville rocks of the south central portion from the main body of anorthosite to the west. This 'wedge' is approximately 2 1/2 miles wide at the southern boundary of the map and tapers towards its northern limit, 6 1/2 miles north. Reference to the map will show other masses of the rock.

The quartz-mangerite, on fresh fracture, is greenish grey, but it invariably weathers to buff or dull rusty grey. The gneissose character of the rock is definite, but nowhere is its banding as marked and as regular as that of the sheared anorthosite. The darker bands contain augen and other evidence of brecciation, whereas the fine microbreccia and accompanying interstitial material form the light greenish grey bands. Most of the augen are plagioclase, although relics of microperthitic potassic feldspar are common. In size they vary considerably, but average 10 mm. in length, about 3 mm. in thickness and 5 mm. in breadth. When augen are not present the rock resembles a coarse microbreccia.

The essential minerals of this rock are quartz, plagioclase, and potassic feldspar. Plagioclase makes up 12 to 35 per cent of the rock, with a mean of 23 per cent. The calcity of the plagioclase averages An_{27}, varying between An_{20} and An_{35}. The quartz averages 25 per cent and is usually in clear foliae or pencils. It has apparently crystallized late, and does not normally show strain shadows.

The potassic feldspar averages 39 per cent, varying between 30 and 60 per cent. This mineral does not always take the same form. In some specimens it is part of the microbreccia groundmass and is invariably clear, undeformed and interstitial to the plagioclase. In many rocks, megascopically identical with those of the preceding variety, potassic feldspar remnants are found instead of plagioclase augen; invariably, such potassic feldspar remnants have a perthitic micro-structure. In the groundmass, the potassic-feldspar may or may not be perthitic, the non-perthitic variety is commonly interstitial. Some of these interstitial non-perthitic feldspars are small; others are so large as to constitute a major part of the rock, and their apparently poikiloblastic habit suggests a growth by replacement. Thus, the potassic feldspars of these augen rocks could be of three different ages — a pre-deformation perthitic type, a post-deformation clear interstitial variety, and a clouded replacement variety.

The mafic constituents never exceed 15 per cent of the rock and are made up commonly of iron ore minerals, augite and hypersthene. Biotite, hornblende, chlorite, and sericite may also be present. Apatite is a common accessory, with some zircon and garnet.

According to Tröger (1935), this rock should be classified as a calc-alkali granite, that is, a rock with less plagioclase than alkali feldspar, more than 10 per cent quartz and 10 per cent or more of mafics. According to the Pirsson classification it belongs to the quartz-monzonite group and should be called a hypersthene-quartz-monzonite, or better, a quartz-mangerite (Tyrrel, 1929; Osborne, 1936). It is believed that this rock may correspond to some of the members of the Adirondacks quartz-syenite facies described by Buddington (1939).

The quartz-mangerite is in its typical exposure a coarse augen gneiss, which grades into a coarse microbreccia, and at localities of greater stress these grade into a finer grained, well-foliated rock of sufficiently different appearance and adequate extent to be mapped separately as sheared quartz mangerite.

No actual contacts were observed either between the Grenville rocks and the quartz-mangerites, or the quartz-mangerites and the anorthosite. As the relationship between the latter rocks is considered to be of prime importance such a contact was searched for carefully. None was observed, but angular inclusions seen at the Caron cottage by the head of Duffy lake, in the anorthosite close to the presumed contact, could be gabbroic anorthosite, meta-gabbro, or possibly even quartz-mangerite.

JEAN VENNE GRANITE

The Jean Venne granite is dark grey to chocolate brown in colour and medium-grained. It differs from all other rocks of the district in that it shows little or no evidence of shearing. The following average composition is derived from several thin sections, and indicates that the rock is an alaskitic granite:

Potassic feldspar (perthitic)	63.5 %
Quartz	29.5 %
Iron ores	1.5 %
Biotite	1.4 %
Muscovite	0.8 %
Apatite	0.4 %
Hypersthene	0.3 %
Augite	0.3 %
Hornblende	0.1 %
	97.8 %

The potassic feldspar is in anhedral grains from 0.2 mm. to 2.0 mm., and averaging 0.6 mm. The microperthitic structure of the mineral is most prominent and is seen in almost all feldspars; in some grains it becomes perceptible only under high magnifications, but this is exceptional. In most of the feldspars these microstructures are so prominent that they give the mineral a 'shadowy' appearance. This is believed to be the cause of at least part of the dark colour of this highly acidic rock. The perthite is mainly of the exsolution type, that is, it is in fine, elongated, lenticular blebs generally parallel to 010. The intergrowth is similar to that termed "eutectoperthite" by Mawdsley (1927) from Saint-Urbain.

In one slide the perthite occurs as small, subrectangular patches in a definite alinement. This rock, which comes from the exposure of granite on the edge of the range IV road, one mile southwest of Saint-Théodore, has a totally different appearance from that of the

Jean Venne granite; it could be a granitic facies of the quartz-mangerite but, being unsheared, has been mapped with the Jean Venne granite.

The quartz is interstitial to the feldspars, but some of the feldspars contain small rounded inclusions of it. The two minerals have also been observed in a micropegmatitic intergrowth. Under high magnification, both the quartz and the feldspar show innumerable very fine inclusions similar to those found in the massive anorthosite. Here, however, the inclusions do not have the same orderly arrangement as those in the plagioclases of the anorthosite. Here, also, the inclusions are believed to play a large part in the pigmentation of the rock.

Among the accessory minerals, the iron ores, biotite, apatite, hypersthene, augite, and zircon are thought to be primary, whereas hornblende and muscovite, frequently as very fine crystals of sericite, are considered secondary.

In the field, the Jean Venne granite is generally massive. Here and there, however, semi-lenticular, sub-parallel quartz-filled fissures give to the weathered surface of this rock the appearance of some of the rocks of the Grenville series. This quartz is blue grey in colour and is believed to be an endstage product which has filled cracks in the cooling granite. Some thin sections show structures of an undoubted post-crystallization type. These are similar to the structures of the anorthosites shown in Plate VIA.

A fresh, relatively unsheared gabbro occurs at three localities within the area occupied mainly by the Jean Venne granite. This cannot be correlated either with the anorthositic gabbros or with the later diabase dykes and is believed to be related to the granite. One exposure is behind the parish church at the village of Saint-Théodore, and another is by the old Aumont mine. The third and best exposure is along a scarp three-quarters of a mile due west of the point where the Paré Lake road crosses Jean Venne river. The rock is melanocratic, and shows a granitic texture with grains between 1 and 3 mm. It consists of anhedral labradorite surrounded by ortho- and clinopyroxenes, hornblende pseudomorphic after the pyroxenes, sideronitic iron ores, and a few grains of a green spinel, probably hercynite. The feldspars all have a wavy extinction and some of their interstices are filled with a microbreccia of feldspar and mafic minerals. This sheared structure is very similar to that found at the periphery of the Jean Venne granite.

PEGMATITES

Pegmatites are not numerous in this area. They were seen in Grenville rocks, in anorthosite, in quartz-mangerite, and in the Jean Venne granite. With rare exceptions, the pegmatites are pink with coarse (up to 1 inch diameter) feldspar crystals showing curved cleavage planes, much quartz (up to 1/4 inch diameter) of interstitial and of lamellar habit. Many of the pegmatites have been sheared and a foliation and even a marked lineation have developed in them.

The pegmatites were observed to cut the anorthosites in ten places, only two of which were in the Ashton facies. In the Chertsey facies, most of the dykes are in the vicinity of a line joining Fourth chute of the Ouareau river and Gratten lake. At both of these places, the dykes are thin, short, and irregular. The appearance and habit of the pegmatites demand comparison with that of the pink granite gneiss; megascopically the one appears as a sheared variety of the other. In the vicinity of Saint-Théodore village, two or three medium-grained, unsheared, pink pegmatitic rocks cut the granite gneiss. Of the pegmatites observed during the season, the best exposure lies 50 feet or so west of a point on Highway No. 18, 100 paces west of the Paré Lake road junction. This rock is pink, coarse and sheared, and, because it is sheared, it is probably not associated with the Jean Venne granite. Thus, it appears that there are at least two ages of pink pegmatite, the earlier of which could be related to the pink granite gneiss.

DIABASE DYKES

Thirteen late diabase dykes, from a few inches to approximately 100 feet thick, were seen in the area. One dyke cuts the light grey syenite northeast of Bissonnette lake; all others intrude the anorthosite, three in the Ashton facies and nine in the Chertsey.

By far the largest dyke seen lies in the valley of the Ouareau where the river enters the area; this dyke was followed for 1 3/4 miles along the valley floor and is about 100 feet at its thickest cross section. The maximum grain size is about 4 mm. The rock is a quartz diabase, in which quartz amounts to 15 per cent of the total and is in a micrographic intergrowth with the plagioclase (An_{65}). This feldspar makes up over 45 per cent of the rock. The dark minerals are hypersthene, biotite, and titaniferous iron ores. Apatite forms over 5 per cent of the rock. The ophitic texture is marked, the interstices between the plagioclase being filled by subhedral mafics and the anhedral micrographic intergrowth. All of the minerals show a slight waviness of extinction.

Another diabase dyke is found in the Jean Venne valley where the river is crossed by the secondary road leading to Michel lake. Here the diabase has 50 per cent plagioclase (An_{85}), much pigeonite, some iron ores, some apatite, but no quartz.

STRUCTURAL GEOLOGY

The broad picture offered by the rocks of the region is as follows. To the northeast lie the Grenville gneisses (metasedimentaries) with foliation that strikes about N.15^{o}W. At a distance from the anorthosites, these gneisses are locally closely folded; nearer the contact, the foliation dips at a low angle, and, at the contact, the foliation of the gneisses is parallel to that of the sheared anorthosite. Throughout most of the region underlain by the sheared anorthosite, the foliation is N.20^{o}W. and the dip 20^{o}W. Exceptions to this are found in the vicinity of Vails and Savard lakes and around the inclusion of Grenville which lies east of Grande Jetté.

The Grenville rocks lying between the anorthosites on the south form a westerly-dipping, inclusion-like mass with boundaries trending parallel to the foliation of the Chertsey anorthosite. Reversals of the foliation dips within the 'inclusion' indicate that folding has occurred there.

The shape of the main body of the quartz-mangerite is suggestive of a sill lying between the large 'wedge' of Grenville rocks and the overlying narrow band of Chertsey anorthosite; its structures are conformable to the enclosing rocks and show gentle dips. The mass south of Patrick lake cross-cuts the massive anorthosite. The mass of sheared quartz-mangerite at the northeast corner of the map has a broad, irregular, sill-like appearance. This body appears to underlie the anorthosite, and its contacts against the quartz diorite gneiss are conformable. However, the lower contact of this sill with the underlying Grenville rocks is irregular. The Jean Venne granite was emplaced along the zone of weakness formed at the nose of the Grenville 'wedge'; from here it appears to cross-cut the local structures into the massive anorthosite.

Although the Grenville rocks show a marked foliation and lineation, at no place was it possible to distinguish definitely in the field between layering caused by metamorphism and any relics of pre-existing bedding in the earlier sedimentary rocks from which most of the Grenville rocks are believed to have been derived.

In the massive anorthosite, both the phenocrysts of plagioclase and the mafic constituents of the rock have a tendency towards an indistinct planar arrangement. The indefinite nature of the alignment frequently made it impossible to estimate the dip of the planes. It will be recalled, also, that most of the Ashton facies show an incipient cataclasis and that, locally, this is quite marked.

The universally microbrecciated and foliated character of the Chertsey facies was discussed earlier and it was concluded that the granulation was cataclastic. Plates VI and VII (photomicrographs) show the gradation in the degree of granulation of the anorthosites.

The microstructure of the quartz-mangerite was shown above to be protoclastic, and this is true also of the sheared quartz-mangerite gneiss. The quartz-diorite gneiss has a protoclastic structure. The sheared quartz-mangerite gneisses and the pink granite gneisses are, in many cases, narrow sills intruding zones of weakness, notably along the eastern contact of the southern Grenville 'wedge'. In such exposures the lineation in the orthogneisses implies a crystallization under conditions of stress and possibly also movement after consolidation.

The Jean Venne granite shows little to no shearing except at its periphery where there is a slight granulation. The nature of the second zone of weakness followed by the Jean Venne granite, where it appears to cross-cut the main structures, is rather uncertain. Exposures of Grenville rocks have been found on the western boundary where crossed by the main highway; others lie 1/2 mile west of this point and also west of Patrick lake. These may be inclusions quite distinct from one another. They could also be parts of the main 'wedge' which have become strongly drag-folded, in a manner very similar to the folds south of the village of Saint-Théodore. If this be the case, the western projection of the granite would have been emplaced in the continuation of the zone of weakness which it followed from below the village of Saint-Théodore. Faulting has also been suggested to explain the relationship here, but no evidence of this has been seen either in the field or on the aerial photographs.

It is difficult from the foregoing data to draw any conclusions as to the general relationships in the area mapped. Part of the difficulty is caused by the nature of the granulation in the anorthosite and the uncertainty whether it is protoclastic or cataclastic. As suggested, the granulation that gave rise to the Chertsey type of anorthosite is probably cataclastic for it is found in adjacent formations older than the Jean Venne granite. South of the area mapped, Osborne (1936) has found the variety of anorthosite termed "white anorthosite" by Adams in contact with the Grenville quartzite. Both the foliation of the anorthosite and the bedding of the Grenville are steep and the granulation does not extend into the quartzite as it does near Saint-Théodore. Furthermore, the granulated white anorthosite has a simple mosaic texture and no exsolved potassic feldspar. This may be taken as evidence that the white anorthosite is protoclastic and it probably represented a dyke-like feeder to the main anorthosite mass. No doubt similar protoclastic anorthosite was once present in the Chertsey area, but its structures have been obscured by the Chertsey cataclastic deformation.

The structures within the Ashton anorthosite are so faintly defined that it is difficult to determine the attitude of the primary structures. However, in the region west of this, the primary structures appear to have gentle dips, which suggests that a large area of the massif is a stratiform body, possibly a laccolith. The intrusions younger than the anorthosite would tend to follow the outlines of the anorthosite and hence would conform to its structure.

It is a commonplace that few faults have been found within the Laurentian region; this is partly because the formations are lenticular and faults are difficult to recognize but perhaps more adjustment took place under deep seated conditions than in the zone of fracture. The distribution of the formations near the northeast corner of the map suggests that a fault striking N.60°E. displaced the formations on the northwest side to the east.

Joints are common and commonly strike at right angles to the strike of the foliation. It is probable that some of the streams follow the joints particularly where the jointing is more closely-spaced than usual.

ECONOMIC GEOLOGY

Gold

There was much talk of gold in this locality in the 1860's, and a few pits were dug in places showing some pyrite. A stamp mill was erected on the banks of the Ouareau to process the 'ore' from one of the pits. Although these projects have long since been abandoned, the inhabitants still talk of gold and will readily refer one to the 'mine à Aumont', the 'mine à Patrick', etc. Adams (1895) reported on these pits. During the present survey, most of the few quartz veins encountered were sampled. Specimens were also taken at the pits mentioned above. All assays gave "nil" for gold. The two main pits are located on lot 2, range IV, and lot 15, range V, township of Chertsey.

Silver and Lead

Traces of silver have been reported from a quartz vein cutting the anorthosite east of Patrick lake.

Silver-bearing veins have been found in Grenville rocks. Of the latter the best assays were obtained from a specimen from a pit sunk by Mr. Trudel on ground near lot A, range IX, of the Gore of Kilkenny. A selected specimen taken by the writer gave 4 per cent of lead and 0.68 ounce of silver.

Two shallow vertical pits were dug 40 feet apart along strike on two narrow veins of quartz within garnetiferous gneisses of the Grenville series. Both veins are conformable to the Grenville rocks, and strike N.50°E. and dip 45°west. The thicker vein, from which material was taken for the assay given above, is from 4 to 6 inches thick. It is made up of blue grey quartz containing rusty foliae with thin bands of galena, one cube of which measured three-quarters of an inch on the edge. No zinc was reported in the assay. The second vein is about a foot above the other and is 3 to 4 inches thick. A picked hand-specimen of this gave silver 0.09 ounce a ton, but no gold, lead, or zinc. This occurrence may be significant because several small deposits of lead and zinc have been worked in similar rocks.

Titaniferous Iron Ores

Concentrations of ilmenite were observed by the writer in four or five localities. This mineral is found as an essential constituent of some of the sheared gabbros of the Chertsey facies. In one instance, a concentration was seen within the massive anorthosite. None of the observed bodies are of sufficient size or grade to attract serious attention. One assay shows about 22 per cent Fe and 9.2 per cent Ti, and it is not unlikely that commercial deposits of ilmenite could be found in this easily accessible area. Should some of the metallurgical problems offered by this type of ore be solved, prospecting for it in this area sould be warranted.

Concentrations of ilmenite were found on lot 6, range X, Chertsey township, on the convex shore of Catherine lake; on lot 5, range VIII, Chertsey township, at the outlet of Racine lake formed from the discharge of Lafontaine lake; on lot 6, range VI, Chertsey, some 1,000 feet west of the range road; and on lot 7, range V, Cathcart township, due west of Crépeau lake, on the Garreau Lakes road.

Some of the iron ores found in the anorthosite gabbros are attracted by the magnet. It should be recorded also that the compass was seriously interfered with at three different localities: on the east shore of Godon lake, on the south shore of Patrick lake, and on a hillside of lot 58, range I, Wexford township; these three localities are underlain by quartz-mangerite or its more sheared facies.

Pyrite

This mineral is disseminated throughout much of the anorthosite, whether sheared or massive. No commercially-significant concentrations were seen.

Industrial Minerals

Garnet is a common mineral in the highly metamorphosed gneisses of the Grenville series. Garnet crystals as much as one inch in diameter are common. It should be noted that all the garnet showed fractures.

Graphite was likewise found in some of the Grenville gneisses. A grab sample, from a locality showing more than the average, gave a return of 2 per cent of graphite.

The absence of commercial deposits of mica and associated minerals may be ascribed to the few dykes of pegmatite in the area. The inhabitants make frequent mention of 'mica mines', but investigation has shown most of these to be non-existent. On lot 1, range III, Chertsey, some of the gneisses show a higher than usual content of mica, but this is by no means of any immediate economic interest. One concentration reported to be located in the steep hills of the east bank of the Ouareau, one mile above the White Lake dam, was not investigated as it lies well outside of the area.

The purity of some of the anorthosites and their high tenor of Al_2O_3 suggest that an industrial use may be found for them.

Limestone was seen in a few localities, one of which was the site of a very old quarry. All observed bodies of crystalline limestone are very small and lenticular and would not in themselves be of any economic interest today. But the proximity of several exposures of these rocks to quartz-mangeritic intrusions and the consequent development of skarns and serpentine limestones, implies the possibility of finding in this region magnesitic dolomites such as those being worked today southwest of this area.

Very few of the rocks observed could be successfully quarried as building stone. Some varieties of anorthosite are attractive but the difficulty of working the stone militates against its use. Some of the varieties with opalescent plagioclase, could be quarried and polished to provide a decorative stone to compete with the larvikite from Norway which adorns many store fronts.

Gravel deposits mostly of glacial origin are widespread. In general, they contain too much sand to provide good material for road construction. However, in some localities, the gravels have been sorted by recent streams so that they form road metal of good quality. An extensive gravel bed of this type may be observed along the east bank of Ouareau river, at the Grande Jetté, approximately 5 miles north of the 'government bridge'.

APPENDIX

Mining Developments from 1947 to 1959

by

J.-E. Gilbert

Exploration work was carried out between 1953 and 1956 in the southwestern part of Chertsey township on the property of Laurentian Titanium Mines Limited and, following geophysical surveys, geological mapping and diamond drilling, the company reported the discovery of a small deposit of ilmenite and titaniferous magnetite carrying about 19.9 per cent titanium dioxide and 27.3 per cent iron.

November 14, 1959.

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