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CHARPENEY - COOPMAN - BAILLOQUET MAP-AREA (SAGUENAY COUNTY)

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CHARPENEY - COOPMAN

BAILLOQUET MAP-AREA

M.A. Klugman

Final report

1977

DP-475

GOUVERNEMENT DU QUEBEC

MINISTERE DES RICHESSES NATURELLES

EXPLORATION GEOLOGIQUE

CHARPENEY - COOPMAN - BAILLOQUET

MAP-AREA

Saguenay County

by

M.A. Klugman

1955

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CHARPENEY - COOPMAN - BAILLOQUET MAP-AREA

SAGUENAY COUNTY

by

M. A. Klugman

INTRODUCTION

Location

The Charpeney-Coopman-Bailloquet area was mapped by the writer during the summers of 1953 and 1954. It is bounded on the south by the gulf of St. Lawrence and extends inland for about 16 miles to latitude 50°30'N. On the east and west it is bounded by longitudes 64°55'W and 65°35'W, respectively. The map-area includes Charpeney, Coopman and Bailloquet townships parts of Rochemanteux and Touzel townships, as well as a three-mile-wide strip along the northern border which has not been subdivided into townships. In all it covers about 440 square miles. The western boundary of the area is 35 miles east of Seven Islands (Sept. Iles), a

town on the north shore of the St. Lawrence, 325 miles below Quebec City.

Access

The area is most easily reached by sea-plane, from a base at Lac des Rapides, near Seven Islands. The only lakes within the area suitable for landing larger sea-planes are Boutereau and Delaunay lakes in Charpeney County in the west, Touzel lake in the extreme eastern section and Des Eudistes, half within the north centre of the area. Landings can also be made on Jeanne-Mance, Vibert, Trevor and Fortin lakes by smaller sea-planes. Water landings along the coast can be undertaken at high tide in the mouths of Manitou and Sheldrake rivers, in the south centre and east respectively.

The area may also be reached by fishing boat from Moisie, a small village at the mouth of the Moisie river, about twelve miles east of Seven Islands, and also from the villages of Rivière-au-Tonnerre and Sheldrake, seven miles and one mile east of the area, respectively. Good anchorages are to be found at the mouths of Bouleau, Manitou, Aux-Graines, Chaloupe and Sheldrake rivers.

Travel within the northern half of the area is not easy, but a number of good portages facilitate access to the southern part. Five major rivers flow southward across the map-area. From west to east they are Bouleau, Tortue, Manitou

in the centre, Chaloupe, and the Sheldrake in the extreme east. Manitou and Sheldrake rivers are both navigable by canoe along the greater part of their lengths within the map-area, and where not, good portages link the navigable sections. Chaloupe river has a steep gradient with many waterfalls and rapids, and at no time is it suitable for navigation. Bouleau and Tortue rivers also have steep gradients and numerous rapids, and vary seasonally from torrential streams to almost dry water-courses, and are, therefore, poorly suited for navigation by canoe.

All the rivers flow over steep falls into deep gorges near the coast, but on Manitou and Sheldrake rivers the falls are skirted by well used portages.

An excellent portage runs from the sea, at the mouth of Manitou river, northward to Des Eudistes lake in the central section of the map-area. This excellent trail is from twelve to twenty feet wide, and most of the creeks along its route are spanned by bridges. Another good portage starts four miles from the coast on the east bank of Sheldrake river and runs northward, parallel to the river, for five miles, where it again joins the river. This portage was cut to avoid the dangerous narrow gorge in which the river runs along this stretch. In Charpeney-Cooqman townships old portages, in poor condition, were recut by the writer's party in 1953. These portages act as connecting

links along the north-south water-route across the area formed by Fabien, Boutereau, Grace, Delaunay and Thérèse lakes and Sault-Plat river. Two major portages were cut during the same summer. The first, eight miles long, follows closely Bouleau river on the west side. The second, three miles long, runs easterly from Delaunay lake to Tortue river. A good portage runs along the coast, between Sheldrake and the mouth of Manitou river, joining the small fishing village of La Chaloupe to these points. Besides these portages, a number of hunter's trails traverse the southern section of Baillooquet township.

Inhabitants

La Chaloupe at the mouth of Chaloupe river is the only inhabited village in the area. The village is partially abandoned with only six of the original 20 families remaining. Rivière-aux-Graines was a village of 30 families, but was abandoned five years ago. Other inhabitants are the fire - rangers, who work from Manitou river-mouth base, and hunters from the neighbouring villages of Sheldrake and Rivière-au - Tonnerre.

Resources

Timber

The area is heavily wooded with black spruce the

dominant growth. There are balsam fir, white birch, poplar, jackpine and tamarack in subordinate amounts. Lumber operations were carried out around Des Eudistes lake 30 years ago, but were abandoned because of the distance from the mills at Clarke City, west of Seven Islands.

Lumbering is still carried out along Chaloupe and Sheldrake rivers on a small scale. The timber from Chaloupe river is used in a small mill built at La Chaloupe in 1953 by the Bond brothers. The timber from Sheldrake river is transported from the mouth by truck to a mill at Rivière-au-Tonnerre.

Fur-Trapping

Fur-trapping was carried out extensively in previous years but has now dropped off considerably due to the low price of pelts. Beaver, otter, muskrat, mink and fox were the principal varieties trapped.

Fishing

Previous to the development of Seven Islands and the railroad, the principal occupation of the inhabitants was fishing. Cod, sea-salmon, mackerel and capelin are the principal sea fish caught. Brook-trout, lake-trout and pike are abundant in all the lakes and rivers of the area.

Agriculture

The soil in the vicinity of the villages is a sandy-loam which is ideal for the cultivation of potatoes.

Water Power

The Manitou falls, one mile north of the mouth of Manitou river have a vertical drop of 120 feet. This drop could be increased by at least 40 feet by the construction of a dam. The large drainage system of Manitou river would ensure a year round supply of water.

Climate

The weather station at Seven Islands has been in operation since 1915. A small station is maintained at the forest-rangers base at the mouth of Manitou river during the summer months. The mean annual temperature at Seven Islands is 26.0°F. The hottest months are July and August with means of 59.9°F and 58.1°F respectively. The mean annual precipitation is 40.75 inches. July and August are the rainy months, each with an average rainfall of about four inches.

Fogs are common along the coast particularly during the spring and autumn.

Field Work and Acknowledgements

The base-map employed was compiled from plans showing surveys of several of the major rivers and lakes. The mapping was done by canoe traverses along the coast and on the larger rivers and lakes. Elsewhere traverses, spaced generally at half-mile intervals, were done by pace and compass, aided by aerial photographs.

J. T. Jenkins, senior assistant (1954), rendered valuable service. Able services were also rendered by A. W. Byrne, senior assistant (1953), junior assistants J. St. Pierre, C. Roberge, A. Brousseau, and F. Fortin, cook for both seasons. The writer is indebted to the people of La Chaloupe, Sheldrake and Rivières-au-Tonnerre, particularly the Bond family of La Chaloupe, for many courtesies during the field seasons.

Previous Work

In 1894, A. P. Low (1) mapped the geology along the upper part of Romaine river and the lower part of St. John river, some 25 miles east of the writer's area. Dulieux (2), in 1911 investigated the Titaniferous magnetite deposits from Moisie to St. John's river.

In 1940, E. W. Greig (3) mapped an area immediately west of that dealt with in the present report.

(1) Low, A.P. Explorations in the Labrador Peninsula: G.S.C., Ann. Rept., vol. VIII, 1895, pp 236 - 237.

(2) Dulieux, E. Preliminary report on some iron deposits on the north shore of the river and gulf of St. Lawrence; Que. Dept. Col., Mines Br., Rept. on Min. Oper, 1911, pp 71 - 134.

(3) Greig, E.W. Matamec Lake map-area: Q.D.M., Geol. Rept. No. 22, 1945.

W. W. Longley (4), in 1944 did a reconnaissance survey along the coast from Chaloupe river to Mingan.

TOPOGRAPHY

Most of the area is drained through Bouleau, Tortue, Manitou, Chaloupe and Sheldrake rivers. All of these rivers have steep gradients, some dropping 1,100 feet within a distance of 16 miles.

The lower reaches of the rivers flow in deep gorges and drop rapidly to the sea through an uninterrupted series of falls and rapids. Apart from Manitou river which is fairly straight, the rivers meander over both sorted and unsorted glacial material, and on nearing the coast, flow in narrow gorges over bare rock.

The local relief of the area is controlled by three factors: joint patterns, the structure of the underlying rock and, to a minor extent, particularly along the coast, glacial gouging and scouring.

The map-area is a dissected peneplain modified locally by lithologic and structural controls. To the west of Bouleau river the topography is very rugged, with deeply

(4) Longley, W.W. Chaloupe river to Mingan, North Shore, Saguenay Co.; Summary report on file with the Que. Dept. Mines, 1944.

dissected intersecting valleys and very few level stretches. The topographic control is a joint system which is aligned in three principal directions; northeast, northwest and north. The pattern of the minor valleys is dendritic. Between Bouleau and Tortue rivers, the northern section is similar to that west of Bouleau, but is more rugged. Southward the relief decreases and the sector south of Delaunay lake is characterised by a more gentle, rolling topography. In this section the control is partially due to fracture systems and partially to the underlying rocks.

East of Tortue river the topography is exceptionally rugged, particularly in the region surrounding Des Eudistes lake. Here elevations above sea-level range from 400 to 2,000 feet, and local relief over distances of half a mile is seldom less than 1,000 feet. This rugged terrain, mostly underlain by anorthositic rocks, extends southward to within four miles of the coast where it flattens out considerably.

The coastal belt, with differences in elevation of about 200 feet, varies in width from two miles in the west, to four miles in the east. Glacial fluting is prominent in some sectors near the mouth of Touzel river where gneiss is exposed as cliffs along the shore. Well stratified Champlain sea deposits mantle a large part of this belt and produce flat and swampy land, especially near

Manitou river mouth, LaChaloupe and Touzel lakes. The underlying bedrock protrudes here and there and has a topographic expression controlled mainly by gneissic structure and jointing parallel to this structure.

GENERAL GEOLOGY

General Statement

The consolidated rocks of the area are all of Precambrian age. Listed in order of abundance, they are: anorthositic and gabbroic rocks, granitic intrusives, syenitic rocks, paragneisses, amphibolites, migmatites, dioritic intrusives and various minor intrusives. In the western half of the map-area, apart from the granitic bodies, the contacts and relationships between the rocks are often difficult to determine. Relative age relationships have been resolved, as far as possible, from contact features and, where these are lacking, from the comparative degree of deformation and metamorphism of the various lithologic units. In the eastern half of the map-area, however, the contacts and relationships are often well exposed, and contacts can, in many places, actually be followed in the field.

Along the coastal belt rocks are largely covered by Pleistocene and Recent deposits with large areas completely devoid of exposures. In other sections numerous exposures of rock protrude through the overlying deposits.

Table of Formations

CENOZOIC	Recent and Pleistocene	Sand, gravel, clay and till
	Unconformity	
PRE-CAMBRIAN	Keweenawan ?	Diabase dykes (not indicated on map)
	Later intrusives	Lamprophyre dykes (not indicated on map)
		Pegmatite and Aplite dykes (not indicated on map)
		Biotite granite and associated gneissic granite and granite gneiss
		Hornblende granite
	Baillooquet igneous complex	Monzonite and Syenite Pegmatite dykes (not indicated on map) Diorite and Gabbroic diorite
		Norite Troctolite, Coronite and Olivine gabbro
		Anorthosite, Gabbroic anorthosite and Banded Complex
	Early intrusive and metasomatic rocks	Augen gneiss and biotite gneiss Porphyroblastic hornblende gneiss Migmatites
	Metamorphosed sedimentary and associated rocks.	Quartzofeldspathic gneisses, Graphite gneiss, Chlorite gneiss, Schists, Amphibolites, Quartzites, Andesine-hornblende-Chlorite gneiss, Hypersthene gneiss, Hypersthene granulite, Hornblende granulite.

Metamorphosed Sedimentary and Associated Rocks

The paragneisses of this area do not resemble Grenville type rocks described by Sir William Logan (5) in the "type area" of Grenville township, Quebec. The gneisses outcrop in the southwestern quarter of the map-area, Tortue river mouth area, the area around Des Eudistes lake, and as small scattered inclusions in some of the later formations. No limestone and very little quartzite was observed, the quartzite generally being found associated with the biotite paragneiss.

Because of the difference between the metasediments of the Charpeney-Coopman-Baillouet area and those described by Logan (6) in the Grenville "type area", the writer feels that the name Grenville should not apply to the metasediments of this area. It has previously been stated that these North-shore paragneisses include very little quartzite and no limestone, whereas in the "type area" these two rock-types are recognised as two of the most typical and abundant constituents of the Grenville Assemblage. Furthermore the rocks of the writer's map-area are more basic in overall composition than those described at Grenville or in other

(5) Logan, Sir William, Grenville County, Quebec: G.S.C., Rept. of Progress, 1858, pp 8 - 45.

(6) Logan, Sir William, op. cit. (5) pp 8 - 45.

areas correlated with the Grenville sediments.

Finally the great distance separating these rock - types from an area known to be of Grenville age, indicates that correlation of the two, with so little evidence, would be extremely hypothetical.

For the purpose of distinguishing this group, previously termed Grenville (7), (8), (9), from the other rock-types of the map-area the term "early paragneisses" will refer to those rock-types listed in the table of formations under the section "metamorphosed sedimentary and associated rocks"

Quartzofeldspathic Gneisses

About eighty-five percent of the metasedimentary rocks found in the area contain abundant quartz and feldspar.

The gneisses are predominantly fine-medium grained, strongly crystalline and vary from light grey to grey-green in colour. Foliation is distinct, and lineation can be observed in all hand specimens. The bands are well

(7) Klugman, M.A. Prel. Rept. on Charpeney-Coopman area, Saguenay County, Que. Q.D.M., P.R. No. 296, 1954, pp 3 - 5.

(8) Klugman, M.A. Interm Rept. on Charpeney-Coopman area, Saguenay County, Que. on file Q.D.M., 1954.

(9) Klugman, M.A. Prel. Rept. on Bailloquet area, Saguenay County, Que. P.R. No. 313, 1955, pp

defined, with light and dark bands alternating.

The critical minerals, from which the name of the gneiss is derived are, biotite, hornblende, graphite and chlorite. Many of these minerals occur together in the same gneiss. Quartz generally shows undulose extinction. Andesine and microcline are the most abundant feldspars.

Biotite and Hornblende Paragneisses. A broad band of biotite and hornblende paragneiss can be traced from the southwestern corner of the map-area northeastward across Bouleau river, where the band turns eastward and passes into a complex of migmatite and composite gneisses. The basis of separation of these gneisses is that the biotite gneiss contains biotite in excess of two-thirds of the total biotite-hornblende content, and the hornblende gneiss contains less than two-thirds. When present in equal quantities the rock is termed biotite-hornblende paragneiss.

Biotite Paragneiss. Petrographically, the grains are equigranular granoblastic with sutured contacts. The biotite flakes are elongated in the direction of foliation, and some quartz grains show elongation in the same direction.

Quartz is usually present in amounts of over fifty percent, while plagioclase and microcline together make up from fifteen to forty percent. The plagioclase is strongly twinned according to the Albite law and often shows secondary crystallisation normal to the direction of maximum stress.

It varies in composition from An_{20} to An_{42}. Alteration to sericite is not extensive. Perthitic intergrowth in the microcline is fairly common. Biotite is pleochroic in shades of honey yellow to brown.

Accessory minerals are apatite, garnet (possibly almendine), sphene, magnetite, muscovite, pyrite and epidote.

Hornblende paragneiss. The colour of the hornblende gneiss varies from light grey to greenish-grey according to the percentage mafic minerals present. The average grain-size is medium. The gneiss has a granoblastic, equigranular texture. The percentage hornblende is diverse, with a maximum of fifty percent.

The hornblende is always pleochroic from yellow to pale green or dark green. The plagioclase varies from An_{23} to An_{39}. Zoning is prominent, with borders more sodic than the centre. Alteration to sericite is not extensive. Biotite and epidote are also present and the accessory minerals are apatite, magnetite, pyrite and zircon.

Biotite-Hornblende paragneiss. This gneiss is intermediate in composition between biotite and hornblende gneiss. The essential minerals are biotite, hornblende, plagioclase An_{20} to An_{39}, and quartz. Accessory minerals are apatite, magnetite, pyrite, sphene and epidote.

Graphite Paragneiss.

Graphite gneiss is found in a few scattered local-

ities, associated with biotite paragneiss. Megascopically the gneiss is fine to medium grained, has a typical rusty colour and consists of quartz, plagioclase, biotite, graphite and pyrite. No thin-sections were examined.

Chlorite Paragneiss.

The chlorite paragneiss resembles the hornblende paragneiss in the field. It is light grey to greenish grey in colour, and varies from fine to medium grained. The texture is lepidoblastic.

The essential minerals are plagioclase, microcline, hornblende, chlorite (pennine), quartz and biotite. The pennine is slightly pleochroic from green to very pale green. Plagioclase varies from An_{38} to An_{44}, and some grains show slight zoning.

Alteration is common from:-

hornblende→biotite→pennine→carbonate.

The feldspars are often indeterminable due to widespread alteration to sericite and kaolin. Accessory minerals are apatite, magnetite and carbonate.

Hornblende Granulite.

The hornblende granulite is pink to buff greyish-green in colour and is medium grained. The rock is well foliated with hornblende and biotite elongated in the direction of foliation. The feldspars show secondary crystallisation normal to the direction of maximum

stress, and most quartz has undulose extinction. Many of the feldspars have myrmekitic textures while in others the quartz was seen to be replacing the feldspars along their margins. In much of the plagioclase the twinning has been erased. The potash feldspar is a microperthitic anorthorclase and the plagioclase has a composition of An_{34}.

The rock is highly granulated with alternating medium-and fine-grained layers. The essential minerals are quartz, anorthoclase, plagioclase, hornblende, biotite and chlorite. Accessory minerals are epidote, sericite, magnetite and apatite. (The quartz and feldspars usually make up about seventy percent of the rock, with quartz as high as thirty percent in some sections). In some thin - sections examined the hornblende has completely altered to chlorite (penrine). Hypersthene occurs in some thin - sections as a minor constituent.

Hypersthene Granulite.

Interbedded with the hornblende granulite is hypersthene granulite with grain size from fine to medium.

The rock is pink to buff greyish-green in colour, with some varieties having augen structure.

The essential minerals are plagioclase, perthite, hypersthene, augite, garnet and quartz, with hornblende, biotite and chlorite as alteration products after pyroxene. Accessory minerals include apatite, titaniferous-magnetite,

sphene, epidote and sericite with carbonate sometimes present.

The rock is highly granulated, and commonly has alternating coarse-and fine-grained layers. Fractures, parallel to the foliation are common, in some thin-sections examined, along which chlorite and epidote have been introduced. Many of the feldspars show excellent myrmekitic textures, and quartz is also found replacing the feldspars along fractures and around the margins of the grains. The twinning in many of the plagioclase feldspars has been partially destroyed, and nearly all quartz shows an undulose extinction. Recrystallisation, normal to the direction of maximum stress, has produced elongation of the plagioclase in the direction of foliation.

Augite is sometimes polysynthetically twinned, and hypersthene shows exsolution of epidote along its cleavage. The hornblende poikilitically encloses feldspar in many thin-sections, and in others chlorite (pennine) forms pseudomorphs after hornblende.

These two rock-types are intimately related, occurring as interbedded fine-and medium-grained layers. There are also scattered narrow bands and lenses of amphibolite and of hornblende schist in these gneisses of the Des Eudistes sector.

Schists

Schists are common in small amounts throughout all the early paragneisses, occurring usually as interbedded layers between the gneisses. They are fine to medium and coarse grained, dark coloured rocks, forming bands up to several feet thick. It is often very difficult to differentiate between the biotite and hornblende gneisses and schists. Petrographically, the biotite-chlorite schist is medium grained, with biotite the predominant mineral. Plagioclase (An_{32}) quartz, hypersthene and hornblende are the other essential minerals. Alteration minerals include chlorite (43%) and carbonate, and pleochroic haloes are often found around zircon grains. Accessory minerals are garnet (almandine), zircon, ilmenite, magnetite and pyrite.

Petrographically, the hornblende schist consists of hornblende, diopside, biotite, plagioclase An_{37}, quartz and microcline.

Amphibolites.

New occurrences of para-amphibolites (of sedimentary origin) were encountered. The difficulty in distinguishing between the ortho-(of igneous origin) amphibolites and para-amphibolites was partially overcome by naming them according to the rocks with which they were associated. Thus, those amphibolites associated with the metasediments are termed para-amphibolites. This classification is not infallible, but does serve to separate the two.

Petrographically, the para-amphibolites are medium-grained and have a clearly discernable foliation. They are composed of hornblende, biotite and plagioclase (An_{34}), with magnetite, sphene and apatite as accessory minerals.

Ortho-amphibolites are found associated with all gabbroic and some dioritic rocks in the map-area. In thin-sections no foliation is seen and the rocks are composed of over sixty percent hornblende, with biotite and plagioclase as the other main minerals.

Quartzites.

Very little quartzite is present in the area. One thin-section of quartzite was examined. The rock shows fine banding with quartz grains showing an elongation in the direction of the banding. It is composed of eighty percent quartz, with plagioclase, biotite and hornblende as the other essential minerals. Accessory minerals are muscovite, zircon and magnetite. Megascopically, it is a fine-grained grey, recrystallized, micaceous quartzite, associated with the biotite paragneiss.

Andesine-Hornblende-Chlorite Paragneisses.

Andesine-hornblende-chlorite gneiss is found interbedded with the paragneisses. In probably represents a band that previously was a more basic sediment than the normal paragneisses found in the area. It is not widespread

and usually occurs associated with the para-amphibolites. The bands vary from an inch to a foot in thickness. Petrographically it is a medium-to coarse-grained granoblastic rock, composed of plagioclase, microcline, orthoclase, hornblende and chlorite. Biotite is also present as a replacement of hornblende. Plagioclase varies from An_{42} - An_{46}, and some grains are zoned. Chlorite is common as a replacement mineral after hornblende and also as a secondary mineral, and shows alteration to carbonate in some grains.

Hypersthene Gneiss.

Hypersthene gneiss was observed in two localities in the area, both near the contact between norite and the paragneisses. Petrographically the rock is medium grained granoblastic with hypersthene as large porphyroblasts. Other minerals are quartz, plagioclase An_{26}, clinopyroxene and biotite. Accessory minerals are apatite and magnetite.

This gneiss was probably formed by the introduction of magmatic fluids associated with the intrusion of the norite.

Origin of the Metamorphosed Sedimentary and Associated Rocks.

With the exception of some of the amphibolites, all the rocks of this group found in the area are believed to be of sedimentary origin. A rough calculation of the thickness of the paragneisses underlying the southwest

quarter of the map-area, at their maximum width of outcrop, would be in the region of 4,000 feet.

Of the total area underlain by this series, over half is occupied by biotite paragneiss. This together with the complete absence of limestone and the small amount of quartzite makes the lithology of this series, in the map - area, greatly different from that described by Logan (10) in Grenville Township.

The presence of quartzite conformably interbedded with biotite paragneiss, and associated with the graphite gneiss, strongly indicates that these rocks are also of a sedimentary origin. Also, the uniformity in composition and thickness of each layer would serve to substantiate a sedimentary origin. Where lit-par-lit- injection has taken place, in the vicinity of granite intrusions, the banding appears to have been sufficiently well developed to confine the injected material completely. Further, were lit-par-lit injections has taken place it has accentuated the banding of platy minerals, which are already strongly orientated parallel to the contacts of each layer. Finally these paragneisses greatly resemble those described by Hogan (11) and Grieg (12), in their respective areas, as being of

(10) Logan, Sir William op. cit. (5) pp. 8 - 45

(11) Hogan, H.R. The Geology of the Nipissis River and Nipisso Lake, map-areas; Ph.D.Thesis, 1953, McGill University.

a sedimentary origin.

Amphibolites of both sedimentary and igneous origin are to be found in the map-area. As previously stated the means for distinguishing the para-amphibolites from the ortho-amphibolites was by their association with either sedimentary or igneous rocks. Those associated with the metasediments were regarded as being of a sedimentary origin. The difference, in composition and intergranular relationships, between the two types is quite marked in the thin-sections. Buddington (13), Adams and Barlow (14) and Barth (15) have suggested different methods for deriving a para-amphibolite from an original lime-rich sediment. As neither limestone nor calcareous slates were observed in the map-area, it must be assumed that these amphibolites are of a sedimentary origin by virtue of their relationship to other metasediments of the map-area and by their difference in composition and texture from those known to be of an

(12) Greig, E.W. op. cit. (3) pp 13

(13) Buddington, A.F. In Greig E.W. op. cit. (3) p 14 (Ref (3) "oral communication")

(14) Adams, F.D. and Barlow, A.E. Haliburton and Bancroft Areas: G.S.C., Mem, 6, 1910, p 104.

(15) Barth, T. Zur Genesis der Pegmatite im Osgeberge: Chemie der Erde, 1928, pp 96 - 136

igneous origin.

The ortho-amphibolites found in the map-area are always associated with either gabbro or diorite. Buddington (16) states that "such amphibolites can be proven of igneous origin only by transitions to rock still preserving typical igneous texture". Along the margins of all the major gabbro and diorite intrusions the rock grades from an amphibolite through an amphibolitised gabbro (or diorite) into gabbro (or diorite). Where these bodies of gabbro and diorite have been intruded by a later intrusion, the amphibolite borders are possibly due to metamorphism at this time. However, gabbro bodies are also found in areas of older rock where there has been no later intrusion, and these gabbros also have amphibolite margins. Barth (17) states "it is also possible that the intrusions were affected by low-temperature "emanations" or solutions, and that equilibrium relations of the amphibolite facies governed the primary crystallisation of these rocks". It is quite possible that the amphibolites described above, originated in this manner.

(16) Buddington, A.F. Adirondack Igneous Rocks and their metamorphism: G.S.A., Mem. 7, 1939, p 13.

(17) Barth, T. Theoretical Petrology; John Wiley and Sons, Inc., New York, 1952, p 342.

Early Intrusives and Associated Rocks

Migmatites.

Migmatites and composite gneisses occupy about half of the area which is underlain by the metasediments and associated rocks. They are commonly associated with nearby granitic intrusive bodies, but are also found far from any exposure of intrusive rock. The migmatites represent all stages of transition from paragneisses to a rock in which there has been complete admixture through assimilation of gneiss and interchange of material with the magma.

Biotite gneiss and biotite paragneiss appear to be the most easily migmatized rock and usually from banded migmatites. In other places the normally well layered gneisses become highly contorted and deformed by the repeated intrusion of granitic or gabbroic material.

The migmatization of gabbroic rocks results in an equigranular massive rock of the same appearance as the original gabbro, but containing quartz as well as the original minerals. These migmatites are restricted to the contact areas between the granite and the gabbro.

A further type of migmatite was found, in which the original rock, usually a paragneiss or augen gneiss, has been intruded by gabbroic material, which in turn has been intruded by granitic material.

Composite gneisses and complexes have been mapped along with the migmatites.

Porphyroblastic Hornblende Gneiss.

Porphyroblastic hornblende gneiss is exposed as a number of large and small patches, all within the south-western section of the map-area. The rock is coarse grained porphyroblastic, and pink to reddish in colour.

Orthoclase and microcline perthite are the most common minerals, and together with a small amount of plagioclase comprise seventy-seven percent of the rock. The plagioclase present is from An_{37} to An_{45} and is present as an interstitial mineral between the orthoclase or microcline - perthite porphyroblasts. Hornblende forms up to twelve percent of the rock and biotite is present as a secondary mineral after hornblende. Chlorite forms a radiolitic texture after hornblende, and in two of the thin-sections examined, is in a ratio of 2:3:: chlorite: hornblende. Quartz is a minor mineral (up to five percent), usually as an alteration product of feldspar and also poikilitically enclosed in hornblende or biotite. Accessory minerals are epidote, apatite, sericite, magnetite, pyrite and zircon.

The interstitial minerals, particularly plagioclase, orthoclase and biotite show a preferred orientation in the direction of foliation, which strikes east and northeast.

The contacts of the porphyroblastic hornblende

gneiss on the western margin of the map-area, coincide with the contacts of Grieg's "porphyritic granite gneiss" (18). However, quartz was only found as a minor constituent in four of the five thin-sections examined. In the fifth slide, no quartz was found.

Granulation of some of the interstitial material, and secondary crystallisation of much of the feldspar ground-mass in the direction of foliation indicates movement in this direction.

It is the belief of the writer that the porphyroblastic hornblende gneiss is of igneous origin, the original rock having the composition of syenite or quartz syenite.

Augen and Biotite Gneiss.

Augen and biotite gneiss underlies about one-sixth of the map-area. The rock is pink, medium to coarse grained, strongly gneissic and has a pronounced sugary texture.

Generally, the augen structure is absent, but in two areas, one in the northwestern section of the map-area and the other in the south-centre, the gneiss has a strong augen structure. These two areas are indicated on the accompanying Charpeney-Coopman map by A's. Apart from the difference in structure the gneiss has the same composition throughout.

(18) Grieg, E.W. op. cit. (3) pp 15

The essential minerals are quartz, microcline, plagioclase (a very small percentage), orthoclase and biotite. Augen, where present are made up principally of microcline, which is often perthitic. The plagioclase shows slight alteration to sericite, but is usually clear and is from An_{16} to An_{28}. Many of the feldspar grains are zoned, with calcic cores. Two exceptions were noted, both near the contact with the metasediments, in which the cores are more sodic. This might indicate the assimilation of more calcic plagioclase, in the paragneisses, by the intruding magma. Quartz usually has an undulose extinction and usually contains a number of liquid inclusions.

Accessory minerals present are hornblende, sericite, sphene, apatite, garnet, zircon, epidote, chlorite, magnetite and pyrite.

The augen, where present, are elongated parallel to the gneissic structure which is parallel to the foliation and schistosity of the adjoining rocks. This lineation, both in the augen gneiss and in the paragneisses, can be traced from the southwestern corner, through Delaunay lake, to the north central part of the map-area, around Des Eudistes lake. This structure has been slightly displaced by the intrusion of the biotite granite in the centre of the area. The dip of foliation throughout the length of this structure is constantly northerly, except east of

Delaunay lake where it is vertical and very steeply dipping towards the south. This irregularity is probably due to the two intrusions of granite to the east and southwest. East of this point the biotite gneiss has been displaced by the granite, and now strikes north-south the dips towards the northeast. This would indicate that the structure is the limb of a fold which has its synchinal axis to the northwest. A number of minor folds can also be traced in this structure, and two well developed drag folds found within the gneiss serve to partially confirm this structure.

Anorthosite.

Anorthosite underlies about half of the total map-area, from four and a half miles west of Manitou river to east ofthe eastern boundary the map-area. In the eastern half of the map-area it stretches from the northern boundary to the coast and underlies three-quarters of this half of the area. This massif stretches east, along the coast at least as far as St. John's river, 25 miles east of the area mapped.

The difference in composition between the anorthosite underlying the northern section of Bailloquet township and that underlying the southern section enables it to be conveniently divided into two, for descriptive purposes. They are separated by a broad band of monzonite gneiss and a banded complex. This complex will be treated

as a third section under the main anorthosite heading.

The <u>southern body of anorthosite</u> varies in colour from white, through grey and blue to mauve in the coarse-grained variety. It's grain size varies from medium through coarse to very coarse grained with some crystals of plagioclase reaching five inches in length.

The essential minerals are plagioclase (92% to 98%), pyroxene, chlorite, hornblende and biotite. The most common pyroxene present is hypersthene, which is usually present in all thin-sections examined. Diopside and enstatite are sometimes present and in one thin-section examined no orthopyroxenes were present, only diopside. Two types of chlorite were identified, pennine and clinochlore, one of which is always present, as an alteration product and/or chlorite that has been introduced along fractures and cleavages. The plagioclase is from An_{45} to An_{59} with the average plagioclase having a composition of An_{50}. This would then make the southern anorthosite similar to that of the Marcy type as described by Alling (18) in the Adirondacks. The feldspars are commonly highly altered to saussuritic aggregates, and the mafic minerals to biotite, hornblende, chlorite, epidote and carbonate. Other minerals

(18) <u>Alling, H.L. and Kemp, J.F.</u> Geology of the Ausable quadrangle, N.Y. State Mus., Bull 261, 1925.

present are magnetite, ilmenite, sphene, allanite, talc, muscovite and quartz.

Shearing and granulation, accompanied by the loss of twinning in many of the plagioclases, is common in nearly all thin-sections examined. Very few of the plagioclases are completely granulated but rather are surrounded by crushed and re-cemented crystals. The large crystals are seldom round, but are more a rounded rectangular shape. Curving of twin lamellae is also common. Both polysynthetic and pericline twinning was noted in some sections, and the plagioclase is sometimes altered to quartz. Poikilitic inclusion of pyroxene in feldspar is common, indicating that the pyroxene is being replaced by the feldspar.

The anorthosite along and near the coast shows prominent gneissic layering, which is parallel to the regional foliation. This foliation in the anorthosite is caused by the arrangement of the mafic minerals in sub-parallel planes. There is a marked increase in the percentage of mafic minerals present in this gneissic variety, which continues to increase until it grades into the banded complex, in which mafic minerals and titaniferous-magnetite make up more than seventy percent of the rock. However, this foliation is only prominent in a very small percentage of this southern area, and the rock is characteristically massive.

Two prominent joint sets are the chief character-

istic of the southern body. The one is parallel to the foliation, is vertical or has very steep dips towards the north or south. The second set is at right angles to this and has a similar attitude.

The anorthosite underlying the northern and central sections of the eastern-half of the map-area can roughly be classed as a gabbroic anorthosite, although all transitions from anorthosite to gabbro are found. The rock varies in colour from bluish grey to a greenish black, depending on the percentage of mafic minerals present. The grain size varies from fine to coarse with some plagioclase crystals up to an inch and a half long.

Near the western contact of the anorthosite, the rock is more of a gabbroic nature, with a high percentage of mafic minerals. This gabbroic anorthosite is composed of hornblende and hypersthene (thirty-five percent), and dark greyish plagioclase. Phlogopite, biotite and clino-pyroxene are also present, with apatite, ilmenite, chlorite and muscovite as accessories. The plagioclase varies from An_{48} to An_{63}, and all grains have polysynthetic twinning. Some thin-sections showed slight mortar structure, and some outcrops show a gneissic structure with hornblende occurring as streaks or irregular bands in the anorthosite. The foliation is parallel to the contact between the anorthosite, and the granite which lies to the west.

Near the contact the anorthosite is highly granulated, and in places is intruded by numerous granitic and pegmatitic dykes and quartz veins. In these anorthosites there is as much as seven percent free quartz in some areas, and quartz stringers in fractures are a common feature of the more intruded sections.

The main mass of anorthosite in this northern section has the average composition of gabbroic anorthosite. Areas of more, or less, anorthositic composition are a common feature of this body. The "block structure" described by Balk (1⁹), who made a study of a similar feature in the Adirondack anorthosite, was not noted in the Charpeney-Coopman-Baillouet area. No contacts, even under close examination, could be determined, but it was found that there was a graduation in composition over very short distances from a pure anorthosite to a gabbro. The gradation from a pure anorthosite, through all stages to gabbro and back to an anorthosite could be traced over distances as little as one hundred feet. Olivine gabbro also occurs within the massif, but onfurther investigation, it was found to intrude the anorthosite. As its composition is very similar to that of the troctolite, it can be considered as being introduced at the same time, and is, therefore, younger than

(1⁹) Balk, R. Structural geology of the Adirondack anorthosite, Min. Pet. Mitt, Bd, 41, pp 347 - 358, 1931.

the anorthosite.

As the composition of the anorthosite varies so much, it would be more appropriate here to give the composition of the three main varieties separately.

The anorthositic gabbro occupies two-thirds of the area underlain by the northern anorthosite. The essential minerals of this variety are plagioclase, hornblende, pyroxene and biotite. Alteration products observed in all thin-sections examined are sericite, epidote and chlorite while Ti-magnetite, pyrite and apatite are the most common accessory minerals. Calcite, zircon, allanite and limonite are also present in some thin-sections. The percentage plagioclase present is from sixty-seven to seventy-five percent and the composition ranges from An_{35} to An_{56}. The plagioclase is often "dusty", but twinning is everywhere retained. Two types of pyroxene are present, hypersthene and diopside. Most slides only have one but in some thin-section both are present, with hypersthene the most abundant.

Anorthosite occupies about one-quarter of the area underlain by the northern section of the massif. Plagioclase is always present in excess of eighty-five percent, and varies in composition from An_{45} to An_{62}. Other minerals include pyroxene (up to nine percent) hornblende, biotite, epidote, chlorite, sericite, apatite, ilmenite, magnetite and calcite. Both clino-and ortho-pyroxenes are present,

but usually only one variety in each section, although excentions were noted. Hypersthene is the only orthopyroxene, and diopside, pigeonite and augite are the clinopyroxenes.

Fractures and shear textures are common in nearly all sections, and where fracturing is present injection of chlorite and epidote has occurred. Many pyroxenes are surrounded by symplectites, and chlorite, magnetite and biotite have largely replaced the hornblende.

The gabbro which occupies the remainder of the area has a similar mineral assemblage to that of the gabbroic anorthosite, but has less plagioclase and more mafic minerals present. The An content averages 57%, and in some sections garnet and olivine are present. A very garnetiferous variety occurs near the contact with the syenite.

Along the northern contact of the massif, granulation is common, and a sub-parallel arrangement of mafic minerals gives the rock a foliated appearance. The foliation is parallel to that of the adjacent granulites and also to the geological contact. The southern contact with the syenite rocks is a well defined intrusive contact with stringers and dykes of syenite extending into the anorthosite. Here granulation is also common.

The banded complex which lies between the southern body of anorthosite and thesyenitic rocks, is highly foliated

and has a strong pseudostratification. This banded complex stretches from Touzel lake in the east to Rivière-aux-Graines on the coast in the south-centre of the map-area. The strike of the layers is 245°, with small local variations in dip and strike. The dip is usually steep towards the north but dips of as low as 45° were observed. The bands vary in thickness from a few inches up to feet, and have definite sequence. The strike of the complex is parallel to the regional strike. The colour of the various bands varies considerably, but are all shades of green or white, depending on the percentage of mafic minerals present.

The most common variety makes up over fifty percent of the complex and has the composition of a granulated gabbroic anorthosite. This rock is highly sheared and has numerous fractures parallel to the foliation along which chlorite has been introduced. The rock is medium grained, greyish green in colour and is highly foliated. Within the rock itself there is a variation in composition, due to the different relationship of the mafics to the other constituents.

The average composition of this gabbroic anorthosite is:- plagioclase (seventy-five to eighty percent), and hypersthene, augite and hornblende together make up to twenty percent. Accessory minerals include chlorite, epidote, ilmenite, magnetite, limonite and calcite.

The arrangement of the mafic minerals with relation

to the foliation differs. The most common structure is with the mafic minerals uniformly distributed throughout the rock and all having a preferred orientation with their long axes parallel to the foliation. The feldspar is commonly recrystallized and elongated in a direction normal to the maximum stress. The second structure has the mafic minerals concentrated in lens-shaped pods parallel to the foliation. These pods are sometimes isolated and in other cases are joined by their drawn out "tails". The pyroxenes occurring in this manner are usually uralitized. The containing rock in this case has very little pyroxene present, but the overall composition including the pods, is similar to that of the unsegregated variety. Ilmenite-magnetite mineralisation is commonly associated with these bands, occurring as comformable layers and pods within the gabbroic anorthosite.

The other half of the area underlain by the banded complex is occupied by a suite of rocks of basic and syenitic composition that appear to be genetically related to the anorthosite. The attitude and relationships of these rocks to one another and to the gabbroic anorthosite band is the same as that of the gabbroic anorthosite. These rocks include anorthosite, norite, quartzitic gabbro, diorite, syenite and quartz syenite.

The anorthosite has a similar composition to that of the southern massive anorthosite, but is finer grained,

foliated and highly granulated. The norite is slightly foliated and granulated and has as its essential minerals plagioclase (An_{44} to An_{50}) sixty percent, pyroxene (augite and hypersthene) twenty seven percent, hornblende and biotite. Accessory minerals include epidote, chlorite, magnetite, ilmenite, apatite and calcite. The quartzitic gabbro is also slightly foliated and granulated and is composed of plagioclase (An_{45}) sixty percent, pyroxene (hypersthene and diopside) twenty percent, biotite, hornblende and quartz. Accessory minerals are rutile, ilmenite, magnetite, chlorite and apatite. Much of the pyroxene has been altered to hornblende, biotite and chlorite. Quartz is the most common interstitial material and is also found as a replacement of plagioclase.

Diorite has an allotriomorphic texture and is also slightly granulated. Minerals present are plagioclase (An_{37}) sixty percent, hornblende and biotite make up thirty-five percent, and calcite, sphene, magnetite, ilmenite and apatite are the accessory minerals. The syenite present in the banded complex has a highly granulated texture with some sections completely recrystallized. Bands of this nature are confined to the northern part of the banded complex and are probably genetically related to the syenite-monzonite intrusion. The constituent minerals are anorthoclase microperthite (eighty to ninety-eight percent),

hornblende, biotite, plagioclase and enstatite, with iddingsite, apatite, magnetite, zircon, chlorite and haematite the accessory minerals. The quartz syenite has a similar composition and texture but contains up to ten percent quartz.

Troctolite, Coronite and Olivine Gabbro

Troctolite, coronite and olivine gabbro all occur together and are so named to indicate the change in composition that occurs within one body. The olivine gabbros are exposed as a long, narrow strip about a mile to a mile and a half east of Tortue river. A number of small related bodies outcrop near this major exposure. One small body is exposed west of Delaunay lake. The major body has a dyke-like form which runs north south across the regional strike of foliation which is north-east. The exposure is nine and a half miles long, from north to south and varies in width up to one mile. Other exposures of olivine gabbro are to be found in the main anorthosite massif, some of which show definite cutting relations while others appear to grade into the anorthosite.

In the field it is a coarse-grained, massive, dark green coloured rock. Near the contact with the surrounding formations, the texture becomes ophitic. Here the rock is fine to medium grained, has the composition of amphibolite and has a slight schistose structure in places.

Petrographically, the texture is ophitic, with plagioclase, olivine and hypersthene the principal minerals. The plagioclase varies in composition from An_{52} to An_{66}, and to a large extent, in some thin-sections examined, has been altered to Kaolin.

Kelyphitic rims are found in all thin-sections and are the result of the replacement of olivine by hypersthene and magnetite, and of hypersthene by amphibole, biotite and sometimes chlorite after these last two minerals. The hornblende and biotite form coronas around the original olivine and/or hypersthene. The rims are made up of interlocking grains of amphibole and biotite. Two varieties of amphibole are present, the one, strongly pleochroic, optically negative and with a moderate birefringence is hornblende; the other is faintly pleochroic, optically positive and has a high birefrimgence is possibly cummingtonite. Spinel is present in some coronas, intergrown with either the amphibole or hypersthene but always near the contact between the rims formed by these minerals.

These coronas are similar to those found by Shand (20) and discussed by Osborne (21) in his paper on

(20) Shand, S.J. Coronas and coronites. G.S.A. Bull 56, pp 247 - 266, 1945.

(21) Osborne, F.F. Coronite, Labradorite Anorthosite, and Dykes of Andesine Anorthosite, New Glasgow, P.Q. Trans. R.S.C. Third Series Sect.IV. vol XLIII, pp 93-97, 1949.

anorthosites at New Glasgow, P.Q. Brogger (22) described these reaction rims and stated that they are formed by a simple reaction between olivine and plagioclase, under conditions of thermal metamorphism. Hypersthene forms in the olivine and amphibole and biotite in the plagioclase.

Accessory minerals are magnetite, ilmenite, apatite, spinel, garnet and chlorite.

Norite

The fine-grained nature of the norite, as compared to gabbro, serves to distinguish it from the gabbro, but both probably belong to the gabbroic facies.

In the field the rock is massive, fine to very fine grained, with a typical "salt and pepper" weathered surface. An ophitic texture is sometimes seen in the hand specimen, but is not commonly prominent.

There are two varieties of norite, the one hornblende-rich, the other, pyroxene-rich, the latter being the more prominent.

Petrographically, the texture varies from equigranular, granoblastic to ophitic, regardless of the mineral composition.

The pyroxene-rich variety is composed of plagio-

(22) Brogger, W.C. On Several Archaean Rocks from the South Coastof Norway: Norske Videnskaps, Akad, 1,Oslo, Pt II pp 24 - 37, 1935

clase An_{42} to An_{46}, which makes up fifty-six percent of the rock. Hypersthene is the prominent pyroxene and makes up twenty-two percent of the rock. Other main constituents are biotite, hornblende and chlorite, all of which are secondary. Biotite and hornblende are after pyroxene, and chlorite is after both hornblende and biotite. A little augite is also present. Accessory minerals include magnetite, apatite, ilmenite and secondary quartz.

The hornblende variety is composed of plagioclase, fifty-two percent, hornblende nineteen percent, and biotite and hypersthene both about ten percent. Accessories are zircon, apatite, magnetite and ilmenite.

The norite underlies the northwestern corner of the map-area, and produces a rugged, joint controlled relief.

Greig (23) who mapped the area immediately west of Charpeney-Coopman-Bailloquet area in 1940, called the rock pyroxene and hor blende amphibolite and suggested that it is of a metamorphic origin, the original rock being either a diorite or an andesite. However, Hogan (24) in 1953, suggested that it is probably an intrusive igneous body. The evidence obtained from the present writer's work also indicates an igneous origin.

(23) Grieg, E.W. op. cit. (3) pp 13 - 15

(24) Hogan, H.R. op. cit. (7) p 43

Gabbroic Diorite

A small body of gabbroic diorite occurs near the mouth of Bouleau river. This body is definitely older than the surrounding granite gneiss as in places it is intruded by quartz veins. The border facies of the body contains up to twenty percent quartz indicating that it has been introduced from an outside source. In the hand specimen, the rock appears to be a pure gabbroic rock with no quartz present, but on microscopic examination, it was found that the quartz present makes up nineteen percent of the rock. A second body lies to the north of Delaunay lake, but this body is not intruded by quartz, neither do the border facies contain much quartz.

In the field both bodies are medium - to coarse - grained, massive, and dark green-grey in colour.

Petrographically, the rock is composed of plagioclase An_{41}, thirty-two percent; hypersthene, nine percent; and hornblende and chlorite, twenty-two percent. Accessory minerals are apatite, nine percent: ilmenite and pyrite. Near the centre of each body there is up to nine percent olivine present and garnet and sphene are important accessory minerals. Coronas of biotite, hornblende and garnet around olivine are well developed indicating that this rock is genetically related to the coronite.

Diorite

Dioritic rocks are exposed in four localities in the map-area. Three of these occurrences are found immediately west of Boutereau lake in the northwestern corner of the map-area. The fourth is exposed along the coast half-way between Tortue and Manitou rivers in the western half of the map-area. The rock is dark green to black, fine to medium grained, and megascopically massive.

Petrographically the texture varies from granitic to granoblastic, with exceptions being found in the thin - sections of the fourth locality, where the texture is sometimes layered. These alternating medium and fine-grained layers may be due to assimilation of sediments, which are found as small bodies enclosed in the diorite. The essential minerals are plagioclase, hornblende, microcline, diopside, biotite and quartz as a minor constituent.

The plagioclase is from An_{39} to An_{48} and forms up to fifty percent of the rock. In some thin-sections the plagioclase is indeterminable as the twinning is hidden by the high degree of alteration, predominantly to sericite. Where zoning is present, as is often the case, the rims are clear.

Grieg (1945)(25) and Hogan (1953)(26) called the

(25) Grieg, E.". op. cit. (3) p 20

(26) Hogan, H.Rl op. cit. (7) p 55

rock a biotite diorite, but in the writers area, biotite is not always present as a major constituent in many of the thin-sections examined. In others, however, biotite forms up to twenty percent of the rock. Hornblende is present in all of the thin-sections examined and can form up to thirty percent of the rock. Other minerals present are hypersthene, augite, epidote, microline and quartz. Accessory minerals are apatite, magnetite, sericite, chlorite (pennine), zircon, ilmenite and pyrite.

The composition of some of the coarser diorite is very near that of gabbro, indicating that the two rocks are genetically related, or alternatively that the diorite is derived from the gabbro.

Monzonite and Syenite

The syenite and monzonite is exposed in a broad band between the gabbroic anorthosite to the north and the banded complex to the south. The rock is buff to pink, medium grained and strongly gneissic. The weathered surface is often stained to a dirty orange colour, due to the large percentage of iron oxides in the rock and in the surrounding area. A number of contacts between the syenitic rocks and the anorthositic rocks were observed in the field and all showed sharp igneous contacts. The strike of the foliation is parallel to the regional strike of the banded complex and the gneissic anorthosite, and the dip is usually either

steep towards the north or is vertical.

The mineralogical composition varies from a syenite to a monzonite but no evidence of this change is composition can be detected in the field. The change is definitely gradational from one to the other and then back again. The monzonite is the most dominant of the two rock types. Petrographically the rock is highly granulated and to a large extent recrystallized. Nearly all minerals present show strain features, and the mafic minerals show preferred orientation in the direction of minimum stress.

The monzonite is essentially composed of plagioclase, orthoclase, microcline, hornblende, hypersthene and biotite. Accessory minerals are magnetite, ilmenite, limonite, apatite, sphene, sericite and epidote. The composition of the plagioclase is from An_{32} to An_{34} and nearly all orthoclase and microcline has perthitic intergrowth. Quartz is always present as an accessory mineral, usually forming myrmekites with the feldspar, and is sometimes found poikilitically enclosed by hornblende. The percentage plagioclase present is from thirty-three to thirty-seven percent and the potash feldspar is from thirty-five to forty-five percent.

The syenite has a similar mineral assemblage to that of the monzonite but the plagioclase present is never over twenty percent. The potash feldspar, on the other hand, is usually over seventy percent.

Quartzitic varieties of both rocks are common near the contacts with the biotite granite. The relations between the syenite-monzonite rocks and the surrounding rock types definitely shows that the syenite is younger than the anorthositic rocks and older than the biotite granite.

Hornblende Granite

Two areas of hornblende granite are to be found in the map-area. The one is along the northern shore of Boutereau lake and down the east bank of Bouleau river, and the other underlies an area west of Grace lake. The first body extends northward out of the area.

The rock is pink to grey in colour, medium to coarse grained, and varies from massive to strongly gneissic in texture. The proportion of hornblende to biotite varies, and in places where the biotite is in excess of the hornblende, the rock might be termed biotite granite.

Petrographically the rock is medium to coarse grained, with microcline-perthite, oligoclase, quartz, hornblende and biotite as the essential minerals. Accessory minerals are apatite, zircon and magnetite. Biotite is usually secondary, as a replacement of hornblende, The gneissic texture is caused by the alignment of hornblende and feldspar grains. The hornblende granite intrudes all the surrounding rocks.

Biotite Granite

A large body of biotite granite underlies the south-central and center of the map-area. Along the coast this body is exposed from Riviere-aux-Graines, east of Manitou river mouth, to two and a half miles west of it. Two other smaller bodies, possibly stocks, are to be found to the south and east of Delaunay and Vibert lakes respectively. Megascopically, the rock is pink in colour, medium to coarse grained, and often shows a gneissic structure although it is usually massive.

Petrographically, it is hypidiomorphic granular with quartz, microcline, plagioclase and biotite the most abundant minerals. Plagioclase is from An_{12} to An_{32} in composition and is slightly altered to epidote and sericite. Graphic intergrowth of plagioclase and microcline was observed in one of the thin-sections examined. Biotite shows pleochroism from honey-brown to brown, and is altered to chlorite in places. Hornblende occurs as a minor constituent in some of the thin-sections examined. Accessory minerals are apatite, pyrite, epidote, muscovite, sphene and magnetite. Much of the granite is porphyritic, particularly in the vicinity of Manitou River mouth and in the main mass between Tortue and Manitou rivers.

Associated with the biotite granite is a gneissic granite which, in the field, appears to be the result of remobilisation of the augen and biotite gneiss. An isolated exposure of biotite granite which crosses Tortue river in

the south is surrounded by an aureol of gneissic granite. Furthermore, the gneissic granite, to the west of the central biotite granite body is intimately associated with small isolated exposures of biotite granite.

Apart from a slightly greater percentage of biotite and hornblende, the petrographic composition of the gneissic granite is the same as that of the biotite granite. The gneissic granite is strongly foliated. This foliation was the feature which was used to distinguish the gneissic granite from the biotite granite in the field.

Fine-grained granite gneiss is found striking east-west and towards the northeast, along the coast in the southwestern section of the map-area. The rock is pink, fine grained and the structure is strongly gneissic to slightly gneissic. It is found to cut all the older rocks in its area including the tractolite and diorite in the south along the coast. Because of these cutting relations and the similarity of its composition to that of the biotite granite, the writer believes it to be of the same age as the biotite granite.

The essential minerals are quartz, microcline - perthite, plagioclase (An_{14} to An_{28}), biotite and hornblende which is a minor constituent in some thin sections. Accessory minerals are apatite, zircon, sericite, chlorite, magnetite and pyrite.

Pegmatite and Aplite Dykes.

In the western half of the map-area, a large number of pegmatite and aplite dykes cut all the previously described rock types, and for this reason are believed to be younger. This pegmatite varies from coarse to very coarse grained, with pink potash feldspar, plagioclase An_{10}, quartz and biotite or hornblende as the principal minerals. Biotite and hornblende seldom occur in the same dyke. In the larger dykes the crystals reach five inches in diameter.

The aplite is a fine to very fine grained rock, usually found cutting the biotite granite. It is composed of microcline, plagioclase An_{10}, quartz and a little biotite. Garnet is sometimes present,

In the eastern half of the map-area, numerous pegmatites, of three separate ages, were observed. The oldest pegmatite cuts all the anorthositic rocks and is itself cut by syenite dykes. It is composed essentially of potassic feldspar, and a little plagioclase, and also contains small quantities of quartz and biotite. This pegmatite is always found closely associated with the ilmenite mineralization.

This oldest pegmatite is cut by a second set of pegmatite dykes which are entirely composed of pink potassic feldspar and are barren of metallic minerals.

The youngest pegmatite consists of pink potassic

feldspar, quartz and small amounts of plagioclase An_{12}, biotite and magnetite. It is found closely associated with the biotite granite and cuts all the previously described rocks.

Lamprophyre Dykes

Aphanitic to very fine-grained lamprophyre dykes cut all the other rock types in the area. These are not as numerous as the pegmatite dykes, but sufficient were seen to establish that they are younger than all other rocks of the map-area. The rock consists mainly of plagioclase, hornblende, biotite and quartz, and shows a very slight gneissic structure.

Diabase Dykes

Diabase dykes were found cutting all the older major rock types but no relation to the lamprophyre dykes could be established. These dykes greatly resemble certain diabase dykes, in other parts of the Precambrain Shield, that are considered by other writers to be of Keweenawan age.

The rock is dark-green to black in colour, dense and medium - to fine-grained. The essential minerals are plagioclase An42, in a sub-miscoscopic ground mass of hornblende, diopside and biotite. Accessory minerals are magnetite, ilmenite, sphene, apatite and muscovite. The widest dyke observed was forty feet wide, and could not be traced along its strike because of the overburden. However,

a diabase dyke of similar proportions and strike was observed on strike, several miles away. This is quite possibly an extension of this dyke.

Pleistocene and Recent

Large sections of the area are overlain by sand and till, particularly in the south-eastern section of the western half of the map-area, and the southern part of the eastern-half of the map-area. The unconsolidated deposits consist of sand interbedded with pale grey clay and layers of well rounded pebbles and boulders. The beds of sand and clay vary from less than one inch to several feet in thickness. These well stratified deposits can be traced several miles inland, in the valleys of Sheldrake and Manitou rivers. Small isolated patches of well stratified deposits can also be found in the map-area and are probably remnants of a great sheet of unconsolidated material which previously mantled large sections of the area. On the coast at the mouth of Manitou river, these deposits are more than 150 feet thick.

Three old beach levels were determined along the coast. The beach-terraces are all clearly defined and one can be traced across the whole length of the area. Continuous stretches of terrace up to over a mile in length can be observed at a number of places along the coast. The highest terrace, at the mouth of Manitou river, stands at 145 feet

above present sea-level. The second highest is at the mouth of Sheldrake river; this terrace stands at 40 feet above present sea-level. The third, observed and measured at a number of points along the coast, stands 20 feet above sea-level. This 20 foot terrace is the one that can be traced across the map-area, along the coast. Cross-bedding was noted at many places, more particularly in the raised terraces along the coast where well formed fore-set and bottom-set beds are well preserved.

Many of the swamps in the area are caused by the occurrence of sand and clay in depressions in the underlying rocks.

Inland, adjacent to many of the rivers and streams, partially sorted till was seen. Glacial erratics, up to ten feet in diameter, are found on many hill-tops. Glacial striae, noted inland and along the coast, indicate that the Pleistocene ice sheet moved nearly due south across the area. The trend varies from S13°W. west of Bouleau river mouth, due south near the mouth of Tortue river and S2°E. over most of the rest of the area.

STRUCTURAL GEOLOGY

In the western half of the map-area, most exposures of metamorphosed sedimentary and associated rocks are highly deformed and distorted, making it difficult to determine

their general attitude. However, in the paragneisses in the south west, the original structure has been preserved in the form of layering, which is usually parallel to the trend of the geological contacts. In these, the original sedimentary beds have been retained as foliation, schistosity, and gneissic structure. This is born out by the uniformity of composition of the various bands and layers of the paragneisses.

The well-developed gneissic structure of the augen and biotite gneiss, also in the western-half of the map-area, is generally parallel and dips in the same direction as that of the paragneisses, where these two are in contact or in the same area. From this, it is possible to determine the general trend of formations in this half of the map-area. The trend is north-east with the dip towards the north-west. This general north-easterly trend has been displaced in the east by the intrusion of the gabbroic anorthosite and later by the biotite granite mass, but on passing beyond the granite, its northeasterly trend is resumed. In the eastern-half of the map-area the overall structure is relatively simple. The greater part of this eastern-half is underlain by massive gabbroic anorthosite forming a large body which extends into the western-half of the map-area. The rocks of the border facies of this body are commonly gneissic and are found in the north-centre

of the area, south of Eudistes Lake along the western boundary of Manitou river, and in the southern part of the eastern-half of the area. The gneissic structure, as well as the pronounced layering in the anorthosite in the south, strike parallel to the geological contacts and dip steeply.

The layering and other gneissic structures in the gneisses of the Edusites lake area strike N.50°E. and dip about 60° southeast. This trend is a continuation of the northeasterly trend in the western half of the map-area. In the southern part of Baillouet township, the banded complex strikes roughtly N.70°E., parallel to the structure of the adjacent gneissic syenite and monzonite and the gneissic anorthosite. The dips along the coast are all towards the north and vary between 45° and vertical. A few miles inland and near the southern margin of the main anorthosite body the dips are also towards the north and are usually steep.

Minor folds are numerous in the layered anorthosite along the coast. They strike parallel to the local structural trend and are upright and generally symmetrical. The plunge of their axial lines is nearly horizontal and is towards N.30°E. or S.70°W. The plunge of the lineation in the gneissic anorthosite is towards N.30°E. and varies from horizontal to 20° in dip.

The overall structure of the map-area is a north-easterly striking foliation, usually dipping towards the northwest, that has locally been displaced and distorted by later intrusions, particularly anorthositic and granitic.

Faulting

In the western half of the map-area three major faults were observed. A fourth major fault crossing Manitou river is to be found in the centre of the map-area. The first three faults all lie to the west of Bouleau river. The most southern two strike northeast, while the one to the north strikes north-northeast. Slickensides were observed on the eastern wall of the most southerly fault, in the gorge of Bouleau river, where the river flows in the fault. The displacement of the eastern block is upwards and towards the northeast. The slickensides plunge at about fifty degrees towards the southwest.

On the centre fault, the movement is only indicated by the displacement of the porphyroblastic hornblende gneiss. Here, the displacement of the eastern block appears to have been towards the southwest.

The horse in the fault zone of the northern-most fault consists of highly sheared and distorted norite and metamorphosed sedimentary material. The magnitude and direction of movement could not be determined.

The fourth major fault of the map-area

crosses Manitou river three and a half miles north of its mouth and strikes N.30°W. The fault was not observed in the field, but the change in rock types across it and the strong lineation of topographic features point strongly to a fault through this area. Also, outcrops of gabbroic anorthosite near the fault, showed a high degree of granulation.

Minor faults were observed in the southwest, between Bouleau and Tortue rivers, and slickensides were observed on a cliff face just off Manitou river three miles southeast of Eudistes lake. The presence of numerous other faults in the map-area is very probably, but no evidence was observed in the field.

Jointing

Joints play a very important part in the drainage control of the map-area. All of the post-paragneiss rocks are strongly jointed. The granitic rocks in the map-area have complicated joint systems, with the principal joint sets striking north, northeast and northwest. Most joints are steeply dipping, but joints with horizontal and low angle dips are also found.

In the anorthosite, the two major joint sets strike N.30°W. and N.50°E. and dip vertically or nearly so. Horizontal and low angle dips are also present. Two minor joint sets strike N.-S. and N.55°W. In the southern

anorthosite body two prominent sets, both steeply dipping, strike roughly north-south and east-west.

In the layered rocks the prominent joint planes usually lie in the plane of the layers and a less evident set is roughly at right angles to it.

ECONOMIC GEOLOGY

Economic deposits of varying importance were observed in the map-area. Some have comparatively little importance, while others, under future conditions maybe profitably developed.

Garnet

Red garnet occurs as a fairly common accessory in some of the finer-grained layered rocks in the vicinity of Pudistes lake. A more common occurrence of garnet is in the beach sands, along the coast, particularly towards the east. Here garnet is commonly observed as continuous bands in the beach sand after the high tide. The grains, however, are small, seldom being more than one millemeter in diameter. A "garnet-mine" was reported by some of the local inhabitants, several miles north of the map-area, but its exact location was unknown.

Feldspar

A number of pegmatite dykes within the area might form a possible source of economic feldspar. However, they

are comparatively few in number and too scattered for profitable exploitation. The feldspar in the potash feldspar pegmetites is of good quality with individual crystals usually over a foot in length. The granitic pegmatites also have large crystals of potash feldspar which form up to sixty percent of the rock. The larger dykes range up to forty feet in thickness and could be traced over distances of two hundred feet in places.

Also associated with these pegmatites are small (up to 1 cm) crystals of allanite which were surrounded by radio-active haloes.

Biotite

Biotite is a common constituent of most of the rock-types in the map-area. However, the only occrrence of economic interest was found in a pegmatite dyke just east of Sheldrake river one mile north of its mouth. Books of biotite up to six inches thick and eighteen inches in diameter were found in this pegmatite. This, unfortunately, was the only occurrence observed in the vicinity, and no others were reported by the local inhabitants.

Building Stone

The anorthositic and gabbroic rocks of the area have great possibilities as building and decorative stone. The very coarse - grained anorthosites in the south-eastern section of the map-area have great possibilities as a

decorative stone when polished. The labradorescence of the calcic plagioclase is very well developed in some localities. At present, however, these deposits lie too far from prospective markets, but in the future might prove profitable.

Ochre

A "plain of paint" was investigated one mile northwest of La Chaloupe. The swamp covers an area of approximately half a square mile. The deposit is more than two feet deep but its exact depth was impossible to determine due to the raininess of the summer of 1954. The ochre has been used as a pigment in "paint", with which a number of houses in the village of La Chaloupe have been painted.

Sulphides

Finely disseminated sulphides were observed in most of the igneous rocks of the map-area. Pyrite and chalcopyrite are common in most granitic rocks, but their amounts were too insignificant to warrant further investigation. Pyrite, pyrrhotite and chalcopyrite were found in the few graphite gneiss outcrops that were observed. In the anorthositic and gabbroic rocks pyrite is commonly associated with magnetite. Chalcopyrite, pyrrhotite and bornite are sometimes present.

Ilmenite-Magnetite

Magnetite is a common accessory mineral in the gabbroic anorthosite underlying the northern and central

sections of the eastern half of the area. In places it forms up to ten percent of the rock but the observed occurrances are small and scattered and are of little economic interest.

The anorthosite body bordering the shore in the southern part of Bailloquet township commonly contains disseminated ilmenite and magnetite, as well as several notable concentrations of ilmenite-magnetite. The locations of the more important concentrations are noted on the Bailloquet map, accompanying this report, by the symbol "Me". The most notable of these concentrations occur at La Chaloupe and Cap Rond.

The main concentrations occur as stratiform sheets or layers of ilmenite-magnetite, which vary in thickness from fractions of an inch up to two feet and which can be traced for 500 feet at La Chaloupe. A grab sample of one of the layers at La Chaloupe assayed:- Iron, 49.52%, sulphur, 0.08%; and titanium oxide, 16.34%. A channel sample taken across a four-foot wide band of highly mineralised anorthosite at La Chaloupe assayed:- iron, 23.44%; sulphur, 0.35%; and titanium oxide 5.83%. This sample was taken across an average band of mineralized anorthosite, not an ilmenite band. A sample taken from a concentration of ilmenite-magnetite on Chaloupe river, two miles north of the mouth of the river, assayed:- iron, 35.96%, and

titanium oxide, 11.01%. At one of the occurrences at Cap Rond a layer of ilmenite-magnetite forms a band 44 feet wide which can be followed for 100 feet into the side of a hill. The average assay value of eight grab samples taken across this band is:- iron, 35.84%; sulphur, 1.35%, and titanium oxide, 11.37%. Several irregular segregations and lenses, a few feet wide and up to 100 feet long, are also found along the coast and near the southern edge of the main anorthosite mass. Nearly all the concentrations are found within a zone about 2,000 feet wide, along the coast.

A series of analyses of grab samples taken from various layers of massive ilmenite-magnetite at La Chaloupe and Cap Rond is given as an Appendix to this report. The analyses show that the layers, lenses and segregations consist mostly of titaniferous magnetite, although some are massive ilmenite. Metallographic examination showed that hematite is intimately related to the ilmenite and magnetite. In some polished sections, sulphides are present in minor amounts, these include chalcopyrite, bornite, pyrite and pyrrhotite.

The ilmenite-magnetite is generally concentrated in layers of pyroxenite within granulated anorthosite. A characteristic feature of some of the sheets or layers of massive ilmenite-magnetite is a breccia-like structure in which several angular or sub-rounded fragments and blocks of

coarse-grained anorthosite lie within magnetite-rich pyroxenite. The anorthosite in the fragments contrasts with the wall-rock anorthosite, for it is massive, very coarse-grained and light to medium in colour.

It is not known whether larger and richer bodies occur inland, along strike, under the overburden, but further exploration might yield favourable results, particularly at Cap Rond.

APPENDIX I

Location of samples (1954) - Series KE

KE-1 to KE-10	Eight samples taken at regular intervals across Band #1, Cap Rond. Band is 44 feet wide and at least 100 feet long.
KE-11 to KE-13	Three samples taken across Band #2, Cap Rond. Band is 10 feet wide, 100 feet long, and is at 50 feet south of Band #1.
KE-14 to KE-15	Two samples taken across Band #3, Cap Rond. Band is 5 feet wide, and is at 30 feet south of Band #2.
KE-16 to KE-19	Four samples taken across Band #4, Cap Rond. Band is 8 feet wide, and is at 100 feet south of Band #3.
KE-20	Grab sample taken from Band #5, which has a width of 1 foot and is at 75 feet south of Band #4, Cap Rond.
KE-21	Grab sample taken from Band #6, at Cap Rond. This band is 1 foot wide and is 50 feet south of Band #5.
KE-22	Grab sample taken from an ilmenite-magnetite band at La Chaloupe.
KE-23 to KE-25	Three grab samples taken from a lense of ilmenite-magnetite 60 x 20 feet, at 3 miles northwest of La Chaloupe.

KE-26 Channel sample taken across a 4 foot wide band of highly mineralized anorthosite at La Chaloupe. (This is an average band sample, not an ilmenite band)

Analyses of Samples KM-1 to KM-26.

Sample Number		Weight	Iron (Fe) %	Sulphur (S) %	Titanium Oxide %
KM-1	(Wa-5426)	6-oz.	33.50%	1.20%	11.69%
KM-3	(Wa-5415)	16-oz.	34.03%	1.22%	10.31%
KM-4	(Wa-5416)	6-oz.	32.00%	1.16%	11.02%
KM-5	(Wa-5417)	1-lb.	29.16%	1.03%	6.72%
KM-7	(Wa-5418)	10-oz.	33.12%	1.19%	11.00%
KM-8	(Wa-5419)	6-oz.	33.77%	1.35%	11.1[illegible]%
KM-9	(Wa-5420)	6-oz.	33.30%	1.90%	11.85%
KM-10	(Wa-5421)	1-lb.	30.86%	1.36%	13.95%
KM-11	(Wa-5422)	1 1/4-lb.	24.95%	0.89%	8.07%
KM-12	(Wa-5423)	1 1/2-lb.	31.47%	1.07%	12.06%
KM-13	(Wa-5424)	1 1/2-lb.	35.10%	1.25%	10.55%
KM-14	(Wa-5425)	1-lb.	36.02%	1.55%	12.36%
KM-15	(Wa-5428)	1-lb.	36.07%	1.25%	9.97%
KM-16	(Wa-5427)	1 1/4-lb.	33.[illegible]%	0.54%	12.19%
KM-17	(Wa-5426)	1-lb.	28.[illegible]%	0.39%	20.79%
KM-18	(Wa-5429)	1-lb.	48.16%	0.51%	18.89%
KM-19	(Wa-5430)	1-lb.	43.0[illegible]%	0.20%	16.06%
KM-20	(Wa-5431)	1 1/2-lb.	38.51%	0.35%	22.15%
KM-21	(Wa-5432)	1-lb.	42.2[illegible]%	0.08%	38.19%
KM-22	(Wa-5433)	5 3/4-lb.	49.52%	0.08%	26.5[illegible]%
KM-23	(Wa-5434)	1-lb.	11.47%	0.03%	3.6[illegible]%
KM-24	(Wa-5435)	10-oz.	27.[illegible]%	0.06%	10.29%
KM-25	(Wa-5436)	1 1/2-oz.	42.14%	0.10%	16.0[illegible]%
KM-26	(Wa-5437)	10 3/4-lb.	23.4[illegible]%	0.3[illegible]%	5.63%

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APPENDIX II

Fig.1: Glacial gouges at mouth of Sault-Plat River. Charpeney Twp.

Fig: 2. Centre fault-face west of Bouleau River. The face is porphyroblastic hornblende gneiss and the man is standing on biotite gneiss. RochemanteuxTwp.

Fig. 3: Hornblende and biotite schist intruded by biotite gneiss. Charpeney Twp.

Fig. 4: Coarse-grained olivine gabbro cut by pegmatite dykes. Rochemanteux Twp.

Fig. 5: Looking southwest across Tortue River from Coopman to Charpeney Twp.

Fig. 6: Migmatite found associated with gabbro and granite intrusions. Note aplite dyke (left upper centre) truncated by pegmatite.

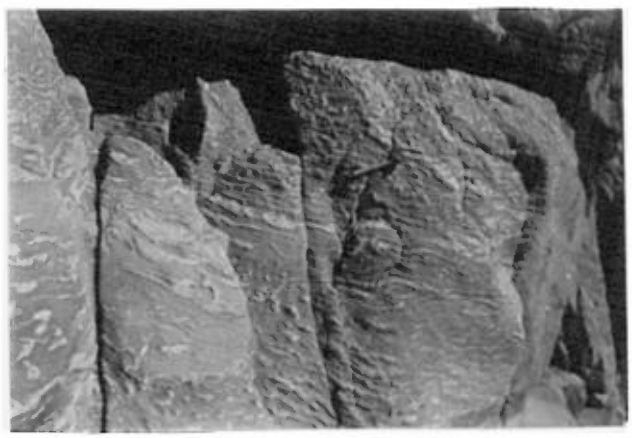

Fig. 7: Buchan Point - Coopman Twp. Highly distorted and deformed biotite schist in biotite augen gneiss. Note quartzite and feldspar stringers.

Fig. 8: Grand Portage, Coopman Twp., from Manitou mouth to Lac des Eudistes.

Fig. 9: Inter-layered hornblende and hypersthene granulite on Lac des Nudistes. The dip is towards the southeast.

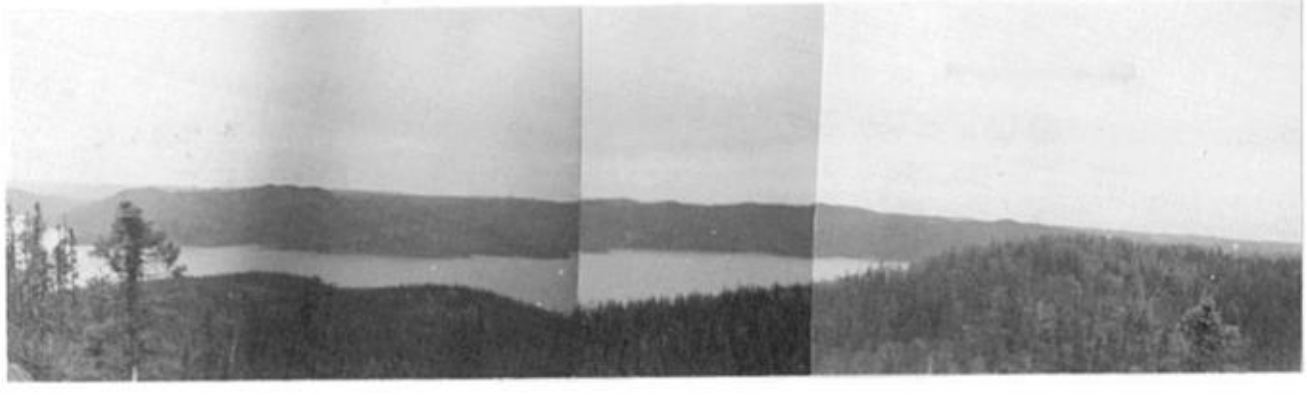

Fig.10: Panoramic view of Lac des Eudistes looking southwest towards Charpeney & Coopman Twps., from fire tower east of the lake.

Fig.11: Drag fold in gneissic anorthosite at Cap Rond, cut by pegmatite dyke (perpendicular to strike). Note jointing parallel and perpendicular to strike.

Fig.12: Typical exposure of coarse-grained massive anorthosite protruding through Cenozoic mantle, Southeast corner, Bailloquet Twp.

Fig. 18: View from gulf of coastal belt underlain by coarse-grained massive anorthosite and overlain by unconformal Cenozoic deposits. Bailloquet Twp.